# SYNOPSIS OF SCIENCE,

IN SANSKRIT AND ENGLISH,

## RECONCILED WITH THE TRUTHS

TO BE FOUND IN

## THE NYA'YA PHILOSOPHY.

BY

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Printed, for the use of the Benares College, by order of Government N. W.

MIRZAPORE

ORPHAN SCHOOL PRESS.—R. C MATHER, SUPT.

MDCCCLVI

*2nd Edition 500 Copies.* *Price 3 Rs. 8 As. per Copy* ]

TO THE MEMORY

OF

JAMES THOMASON,

LATE LIEUTENANT GOVERNOR OF THE NORTH WEST PROVINCES OF INDIA,

THIS ATTEMPT

TO WIN THE LEARNED HINDUS,

AND THROUGH THEM, THE ENTIRE PEOPLE,

TO A UNANIMITY WITH MODERN EUROPE,

COMMENCED UNDER HIS MOST CHEERING AUSPICES,

AND NOW BROUGHT,

HOWEVER IMPERFECTLY,

TO A CONCLUSION,

IS DEDICATED, WITH SORROW AND VENERATION,

BY

JAMES ROBERT BALLANTYNE.

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## INDICATING THE CONCATENATION OF THE SUBJECTS.

# ADVERTISEMENT.

[TO THE 1ST EDITION, OF 1852.]

In order that the precise design of this Synopsis of Science may be understood, the compiler has been directed* to recapitulate briefly the considerations, detailed in the published Educational Reports of the last five years, which have guided his proceedings in regard to the Sanskrit department of the Benares College.

On receiving charge of the Sanskrit College it was my duty to become acquainted with its constitution and history, with a view to introducing whatever improvements might be found consistent with the retention of its character as a seat of Sanskrit learning not unworthy of its classic locality. I was not required to give an opinion whether the funds devoted to the encouragement of Sanskrit learning might be profitably diverted to other purposes. The Sanskrit College was designed to be a permanent institution, and it was not needed that I should deprecate the idea of foregoing in any degree the peculiar advantages offered by such an institution for the advancement of education in India,—advantages for which there could be found no substitute The proximate end, on which these peculiar advantages seemed capable of being brought effectually to bear, is the development of a language adequate to the reproduction of European thought, and the construction of a scientific literature rightly adapted to our educational purposes, by being in a form congenial to the Hindú mind, and free from barbarisms of speech. It was through the Sanskrit, I perceived clearly, that this must be effected, but it has never been contemplated that in the Sanskrit the results should remain locked up. Such then being the proximate end, it is here to be shown, in chronological order, how the end has been kept in view, and what progress has been made in sketching a design which would require many hands for its completion.

From a letter of Mr. Jonathan Duncan, the Resident at Benares, dated 24th December 1798, it appears that the Sanskrit College was at that time founded "for the cultivation of the laws, literature, and (as inseparably connected with the two former) religion, of the Hindoos." The discipline of the College, it was added, was "to be conformable in all respects to the *Dharma S'astra* in the chapter on education" These terms, as I remarked in the Report for 1846-47, "appear to contain the germ of nothing beyond the conciliating of the natives of India by paying a graceful compliment to their language and literature, and of perhaps providing better educated Pandits to act as legal counsellors than could otherwise have been always met with. For many years all the efforts of the various gentlemen who took an interest in the College appear to have been directed to the increasing of its efficiency in these respects" The first decided effort which I found recorded for turning the institution to further account was that of Mr J. Muir, C. S, who undertook the duties of Principal during the session of 1844. Mr. Muir delivered lectures, in Sanskrit, on Moral and Intellectual Philosophy · and the sentiments which he then inculcated have often since that time furnished topics for discussion in the College On the year 1846-47, my impression, as recorded in the printed report, was this,

* [The request came from the late Mr. Thomason, Lieutenant Governor of the North-west Provinces, who desired to have a printed pamphlet to put into the hands of enquirers who had not time to search through the Annual Reports.]

that in the studies of the Sanskrit College all improvement at present must be in the way of addition, not of substitution, because "The most perfect European education bestowed upon a young Brahman, however great a blessing it might be to himself, would exert no beneficial influence beyond his own breast, if unaccompanied by the amount of Sanskrit erudition which is indispensable for securing any degree of respectful attention to his words."

The most interesting experiment of the session 1847-48 was the introduction of the study of English into the Sanskrit College The repugnance of the pupils to this new study was overcome by the offer, to the Senior Students whose period of study was expired, that they should be allowed to retain their scholarship-allowances on condition of their reading English. These men I was very anxious to retain. They had reached a point of mental culture at which they had become worthy of being reasoned with on the comparative merits of the civilization of ancient India and of modern Europe,—a point which the junior pupils were not likely to reach until they in turn should be past the age at which they could retain a scholarship under the existing regulations Government having sanctioned the proposed experiment, the English class of pandits was formed. Its aspect at the opening of the session, as remarked in the printed report, "was not auspicious. The majority of the pupils were very averse to the study, and seemed to think themselves in some measure degraded in the eyes of the other students. They attended reluctantly, when every device for evading attendance failed —books were lost or had not been supplied, pens and ink became suddenly unprocurable, and half the time allotted for the lesson was sometimes spent in settling the fastidiously protracted preliminaries. The pandits seemed greatly to dread being desired to attend in the English College Bungalow, where their slender acquirements in English might expose them to a disadvantageous comparison with little boys who had been reading for a year or two. When they found that no such design upon them was really contemplated, their apprehensions gradually wore off, and ultimately they came over (from the building appropriated to the pandits) to the English department, of their own accord, for several hours daily, in order that they might be within reach of assistance when preparing their lessons." The first want of this class was a suitable English grammar, all the existing grammars being, with reference to the pandits, at once redundant and defective, inasmuch as these manuals take for granted that the learner knows nothing of grammar as a science, and that his vernacular is English or a language of similar idiom. I therefore prepared an outline of English grammar in Sanskrit, which was communicated to the pandits in the shape of lectures, and, after having run the gauntlet of their by no means indulgent criticism, was printed for the use of the class.

In the session 1848-49 steps were taken for bringing about some mutual understanding between the students of the Sanskrit and of the English departments respectively. It was noticed, in the report on the year, as a fact to be lamented; "that the advanced scholars of the English and of the Sanskrit Colleges, though speaking the same vernacular, are mutually unintelligible when the conversation turns on the subject of their studies. The technical terms with which they are respectively familiar, being the product of opposite theories, are not convertible by one who is not conversant with both.

"The consequence is, that the Pandits, in full reliance upon a dogmatic, and, as they think, inspired philosophy, which has stood the discussion (such as it has yet encountered) of centuries, look with calm superiority on the pretensions of a more modest philosophy, which avows that it is only progressing towards that perfection which it cannot hope to reach,—whilst on the other hand our English Students, struck by the imposing methodical completeness of the Brahmanic systems, which they cannot comprehend in detail, and bewildered in every attempt to cope with the dialectical subtlety of the Pandits, who, they see perfectly, though unintelligible to the English Student, are quite intelligible to each other, become possessed by an uneasy feeling, that there is more, if they could but come at it, in the Sanskrit philosophy than is dreamt of in ours. Hence comes the apparent anomaly

that a man who can expound the Newtonian Astronomy, consults his astrologer with the same deference as the most ignorant villager, and confusedly believes in his heart, what the Jesuit Editors of the "Principia" only professed with their lips, that the earth stands still, though the hypothesis of its motion may suffice to account for the phenomena. Hence it is also, that although acquainted with the theory of eclipses, and able to calculate them by European formulæ, he would not on any account neglect to perform the ceremonies ordained for the purpose of helping the luminary out of the jaws of his mythological enemy, the trunkless demon of the ascending node. The only way to remedy this, is to put such a one in a position to judge for himself by making him sufficiently well-acquainted with both sides of the case It is scarcely necessary to observe that a decision in our favour carries ten-fold moral force with it when it is known that the person so deciding knows not merely what he embraces, but also, thoroughly, what he deliberately abandons."

With the view of enabling the students of the English department to meet half-way the Sanskrit students who had began the study of English, two steps were taken during the session 1848-1849 The one was the preparation of an English version of the Sanskrit school-grammar, the *Laghu Kaumudí*, with references and comments —the other was the delivery of a set of lectures on the Nyáya Philosophy. As it may strike the reader, if unacquainted with the subject, that the translating of the *Laghu Kaumudí* was a superfluous labour while English grammars of the Sanskrit already existed, I may be permitted to quote the opinion of Professor H H. Wilson, to whom the first fasciculus (of about a hundred and fifty pages) had been sent Professor Wilson says of the version, "It will be of infinite use to those who wish "to learn Sanskrit substantially and in earnest. I went through the text, as far as "your translation extends,* with one of my Oxford pupils, to his great gratification "and advantage." The peculiar advantage of studying the Sanskrit grammar in the shape in which it is presented in the *Kaumudí* is this, that the learner is thus prepared to avail himself of the rich treasures of Sanskrit philology, which, to the mere reader of the grammar reduced to the European form, are a sealed book. That the philological works of the Hindús contain much that is yet to be gained from them may be inferred from the anxiety expressed by Dr. Max Müller, the editor of the Vedas, that the "Great Commentary" on PÁṆINI's Aphorisms should be printed. An edition, sanctioned by Government N. W. P., is in progress here. †

The text-book taken for the lectures on the Nyáya Philosophy was the *Tarka-Sangraha*. Here, as remarked in the report, "I took sentence by sentence, first giving the original, which my hearers were able partly to understand, then a translation and then a commentary, pointing out the correspondence of each part to the several divisions of European science, and noticing anything analogous in the speculations of antiquity that occurred to me as likely to do good, either by showing that the same truths had been hit upon, or the same errors for a time adhered to, *out* of India as well as *in* it. These lectures were listened to with marked interest, the subject being one which the students are ambitious of understanding,—one which can easily be made clear to them with the aid of explanation in English,—and one which the pandits have not the most distant conception of the possibility of explaining in an exoteric fashion" The Lectures on the *Tarka-Sangraha*, including the text and translation, were printed for the use of the College. The discussion which the translation has undergone has suggested various amendments, and an improved translation (accompanied by a version in Hindí) has had the advantage of being superintended, in passing through the press, by my valued coadjutor Mr. F. Edward Hall.

At the annual examination of 1848-49, thinking that some account of the actual nature of an examination of the Sanskrit College might prove interesting, I selected

* [The version has been since completed. It has been translated (including the commentary) into Hindí, by Pandit Mathurá Prasád Misra ]

† [The first volume, with a translation of the opening portion, has been printed.]

occupy the attention of the native literati. Some of these here follow.

QUESTIONS ON THE VEDANTA OR THEOLOGICAL SYSTEM OF PHILOSOPHY DEDUCED FROM THE VEDAS.

"What answer do you give to the objection that if the Divine Spirit be, as you say, "devoid of qualities, it cannot be made the subject of meditation?"

"Determine what is the real state of the case in regard to the following doubt, viz, whether an elephant and the like, seen in a dream, is or is not produced at that time, seeing "that it has no material cause?"

"How is the opinion of the *Vais'eshika* School of the *Nyáya* sect respecting atoms, to be "refuted?"

"Explain the erroneousness of such opinions as that of the soul's being in the form of "an atom?"

QUESTIONS ON THE SÁNKHYA SYSTEM OF PHILOSOPHY (OF WHICH THE ORTHODOXY IS HELD TO BE RATHER QUESTIONABLE).

"How do you prove that primeval nature has an independent existence?"

"How do you meet the arguments of the Vedantists who deny a duality in the universe, "asserting that nothing exists except God?"

"Prove the existence of the Deity according to the views of the Theistical school."

"How does the soul, in transmigration, enter another body?"

"By what ascetic practices is a knowledge of the past and the future attainable?"

"How do you know that Quietism is right, and in accordance with Scripture?"

QUESTION ON THE NYÁYA OR LOGICAL AND ATOMIC SYSTEM OF PHILOSOPHY.

"What is the distinction recognized by the *Naiyáyikas* between the Supreme Spirit and "the living soul?—and what objection is there to the opinion that, of the two, the latter "only exists?"

"How do you prove that the mind is in the form of an atom?"

"In the opinion of the *Naiyáyikas,* how many kinds of proof are there, and what are "they?"

"How do you prove that gold is identical in substance with light and heat?"

"Before presenting any other questions, it may be well to make some remarks on these. One of the first reflections likely to be suggested by a perusal of these questions is this, that the pupils are taught by one Pundit to establish, of course by irresistible arguments, positions which the Pundit in the next lecture-room teaches him to assail and carry by arguments equally irresistible; and this reflection naturally suggests two questions,—does not this keep the Sanskrit College in a state of feud? and what is the state of the Student's mind after he has gone through the incongruous curriculum? The first question is easily answered. Provided the pupil reads with a given teacher, that teacher seems to have not the slightest objection to his reading with any of the other teachers. With the view of determining in some measure the result of the course of discipline on the minds of the Students, I proposed to the Senior Students the following question.

"As the three systems of Philosophy which you have studied in the College professedly "dispute each other's positions, and cannot therefore all be entirely in the right, tell me "whether you adopt any one of them to the exclusion of the others; or, provided you "really have formed any opinion of your own at all, whether you adopt, eclectically, some-"thing from each.'"

"The answers were generally to the effect that all the three systems were reconcilable with Scripture, and that what appeared in any of them to be a deviation from the truth, was in reality only an accomodation to the weakness of the human understanding, which renders it necessary in the first instance to communicate the truth under the garb of error; just as a mother, in pointing out the moon to her child, speaks of it as the shining circle at the end of her finger, which is intelligible to the child, while the mention of its being distant by thousands of leagues would have hopelessly bewildered him. This is plausible; but the habit of viewing the same assertion as true at one moment and false the next, has,

apparently helped to lead to the existing remarkable indifference as to what is true in itself. Truth, under such circumstances, becomes a matter of taste, concerning which "non est disputandum," except in so for as this disputation my furnish matter of amusement or display We are not here enquiring into these curious philosophical systems as a mere matter of curiosity. The question of questions in regard to them is here—how, and how far, they are capable of being turned to account

"Of the three leading Schools, the *Vedánta*, the *Sánkhya*, and the *Nyáya*, the first, being an attempt to reconcile Hindú Scripture with Philosophy, obviously does not promise much to aid us. The second is as nearly as possible a system of Nihilism, though its advocates protest against imputing that character to it. It contains much that is ingenious, and not a little (as Professor Wilson and others have shown) that has been only recently excogitated in Europe. But as a system, it tends to nothing that we can have any interest in promoting. We cannot make its plan therefore the ground-work of any curriculum of our own. The *Nyáya* on the other hand is a very fair, and, in some respects, admirable, attempt, on the part of certain speculative philosophers, who had made perhaps as many observations and experiments and as they had opportunities of making, to present a complete and consistent physical as well as metaphysical theory of the universe. Of this system, therefore, I have chiefly made use, in laying the foundations of an attempt to present to the Students of the Sanskrit College an equally comprehensive view of the universe, divested of those errors in their own *Nyáya* which modern observation and experiment have shown to be such, and giving somewhat of its due prominence to the physical departments of science, which were much less prominent in the original exposition of the *Nyáya* doctrine than its metaphysics, to which the physics were entirely subordinated as they have ever since remained While their system professes to embrace the universe, it really neglects all that forms the subject-matter of the physical sciences, and consequently its professors look down with self-complacent superiority upon the cultivators of physical science, and with indifference upon its results. The case of Astronomy presents only an apparent exception to this rule, for it is for astrological purposes alone that the bulk of the Brahmins value Astronomy. Here, as in other departments, the knowledge that they have, furnishes too often the main obstacle to their acquiring more. But this is only an additional reason why we should take care to ascertain what it is they have, for whatever they possess of truth, will remain an obstacle, until we make it an ally

"The Hindoo mind, for a long period, has been in what Whewell calls the 'commentatorial stage,' a stage in which originality is forbidden and shunned. This would seem to present one of the occasions when a just appreciation of the history of an analogous period may be fairly expected to throw light upon the prospects of the future, on its undesirable probabilities, and its more desirable possibilities, possible only if they be properly anticipated. To this consideration I shall have occasion to revert. In continuation of the purely Sanskrit portion of the examination, I subjoin some of the questions on Grammar, Rhetoric, Law, Mathematics, and Astronomy. An inspection of these will show that there is here occasion not so much for the Baconian instruments intended to 'originate motion,' as for those that 'direct' it when once originated,—the centripetal force, or wooden yoke, of dogmatic authority, having long since converted, what at the outset was onward progress, into the narrow yet interminable orbit of an ox in an oil-mill.

## Questions on Grammar.

"What is the province of Grammar?"

"Has a word any sense of its own, or is it merely a mark for the thing signified?"

"According to the opinion of the Grammarians (who are at variance on certain points "with the followers of the Nyáya, &c,) what is the real state of the case in regard to this "sentence, viz., Yajnadatta cooks rice?"

"Many other questions were given on this branch, but they related chiefly to the technical treatises on the etymological structure of the language, one of which treatises* I have already mentioned my wish to render accessible to the English reader.

## Questions on Rhetorical Composition.

"What are generally the faults that can be committed in the way of composition?"

* The *Laghu Kaumudí*—since printed.

"What faults can be committed in regard to the management or a simile?"
"What is the difference between a simile and a metaphor?"
"Give some account of the cases in which a metaphor is of such a nature that the thing "for which its tands must or else need not be further hinted."

## Questions on Law.

"Two full brothers are co-parceners; one of them dies childless, leaving a wife; after- "wards the other who has lost his wife also dies, leaving a daughter who is childless, but "whose husband is living. State what right to the property belongs respectively to the "widow and the daughter, according to the *Mitákshara,* and also according to the *Dáya-* "*bhága*"

"A person seated in his carriage drawn by a horse, and driven by an expert driver, is "proceeding along the road, and shouting 'keep out of the way, keep out of the way!' "As luck will have it, a man is driven over, and killed. which is to pay the penalty, the "driver or his master?"

"A she buffalo, with her calf, being entrusted to a keeper during the day time, having "eaten another person's corn, lies down to sleep there unhindered. In this case, what pe- "nalty must the owner of the buffalo pay? How much is the owner of the field entitled "to receive? Is the keeper blameable or not, and if blameable what penalty must he pay?"

"What kind of proof is most effective, and in what kind of cases?"

"Being curious to see what the Students would make of a case for which they could find no precedent in their law-books, I proposed the case which Reid cites as an example of an insoluble dilemma,—of the sophist Protagoras and his scholar. Just as I expected, they tried it by every one of their technical rules in succession, never doubting but that one or other of the keys must fit. When they found, to their great surprise, that this was not the case, they betook themselves to the unusual task of unaided thought; and whilst one decided that the judge must decree in favour of the pupil, another said that he must decree in favor of the master, and a third that he had better dismiss the case without giving any opinion on the matter, which last is the resolution that the Greek judges are related to have come to. The law Pundit, to whom these opinions were submitted, took two days to consider the case, which he also tried in vain by his body of rules which never had failed him before. At this he made no secret of his admiration, but at last he hit upon a solution not uncreditable in my opinion to his sagacity, viz., that the pupil was decidedly entitled to a verdict in his favour, and that then this would furnish good ground for an appeal, in which the teacher must needs gain his point. I mention this as illustrating (what I wish I could illustrate by instances of a character less slight) the lively and salutary excitement which may be created among the Pundits when any thing that they really take an interest in, is presented to them in such a way as to compel them to step out of the beaten track. Unfortunately, in regard to those subjects respecting which their knowledge is most defective, the difficulty is to get them to take any real interest at all. The method which I have found to answer best, is to take as a starting point some established point in their own philosophy, and to show how the philosophers of Europe have followed up the enquiry.

"For example, I found that the Pundits entertained a very low opinion of the European Logic, some account of which had been supplied to them from the popular work of Abercrombie. On this subject I perceived that all my explanations were thrown away, until it occurred to me to enquire carefully whether the knowledge of my hearers did not stop short at some point between which and the knowledge that I wished to communicate, there remained some gap to be filled up, before they could discern that the one was but the continuation of the other. The result was extremely satisfactory. The Pundits, gratified by the admission that their own view of the process of inference is correct so far it goes, laid aside their jealous hostility, which was succeeded by lively curiosity to know how the thing could be carried further;—and thus was obtained, what was wanted, an unprejudiced hearing for what was to be brought forward. It is worth noticing that the very apparatus of technical rules—the "*Barbara Celarent,*" &c.,—which now repels so many in Europe, was hailed at once as an earnest of there being something valuable in the treatise shown to them. The contrivance of significant vowels and indicatory consonants was at once recognized as akin to that of *Pánini* in his institutes of Sanskrit Grammar, and the fact that the system had been matured more than two thousand years ago, invested it with another charm in their eyes.

"These things appear to be worth bearing in mind, for they would seem to indicate that the likeliest way to get the Pundits to lend an unhostile ear to what we have got to say, is to lead them, from the very point to which their correct knowledge has attained, as much as

possible, by the steps which the European mind itself took in reaching its present conclusions after starting from an analogous point. For example, having secured the attention of a set of Pundits to the Aristotelian Logic, and having thereby gained something of additional respect in their eyes, I explained to them the design and character of the *Novum Organon*, and pointed out which division of their own philosophy,—a division avowedly the least satisfactory of all as hitherto treated by their own authors—is represented by this great work. I have found no work the general description of which has more excited the curiosity of the most intelligent of my Pundit auditors than this. Of the way in which we are making use of it I shall have to speak when narrating the studies of the Anglo-Sanskrit class Bacon himself, though as a classic he will always be read, yet is out of date in Europe as the actual guide in scientific investigation. The employment of his own instrument has enabled subsequent enquirers to detect his own deviations from the right track of discovery · but this very fact, if it be carefully kept in view and properly made use of, gives additional value to his writings as an instrument for promoting the intellectual advancement of India"

During this same session of 1848-49, I delivered to my class of pandits part of a course of lectures, in Sanskrit, on 'The Mutual Relations of the Sciences.'* At the examination the following were—

Questions on the Lectures of the Session.

"How many planets are there? what is the form of their orbits? and around what do they revolve?"
"What is the form of the earth? what proportion of its surface is occupied by the "ocean?"
"Marine productions are sometimes found in mountain ranges:—account for this."
"Of what description was the fossil elephant?"
"What is the chemical composition of water, and of atmospheric air?"

The class to whom these questions, in writing, were put and answered in Sanskrit, Mr. D. F. M'Leod, C. S, examined orally on the English books that had been read during the sesson. Mr. M'Leod remarked as follows.—

"I was present at, and a party to, the examination of this Class in the 'Moral Class "book,' Bacon's 'Novum Organum,' and other subjects, interspersed with questions on "Grammar, and was very highly gratified by the result. The acuteness and profundity acquired by these Scholars in the course of their Sanskrit studies, is carried by them into "their English ones, and brought to bear, with great effect, upon every branch of knowledge introduced to them through that medium. Several of them read with considerable "fluency and precision, and though, from the comparative briefness of the period which "has elapsed since they first commenced it, and the great difficulty of English orthography "and pronunciation, much cannot be expected from them in this respect,—yet, from the "answers given, and the mode of treating the subjects adopted by them, the impression is "irresistibly forced on the examiner that the knowledge they have acquired is in reality "greater than it at first appears. the converse probably, of what might with some justice "be said of most ordinary Classes

"The Class is, in my opinion, the most interesting and important in the whole institution. If carried on as it has been commenced, it affords every promise of realizing the "expectation entertained of it by the Principal, with whom exclusively it has originated; "and I most sincerely trust that its aim and object may never be lost sight of, until the "experiment shall have had the most complete fulfilment, and its results been exhibited in "an unmistakeable form."

* The topics touched upon in these Lectures were—Part 1—Astronomy, Geography, Zoology, Botany, Mineralogy, Geology, Chemistry;—Part 2—Arithmetic, Algebra, Geometry, the Calculus, Mechanics, Hydrostatics, Pneumatics, Acoustics, Heat, Optics;—Part 3—Metaphysics and Mental Philosophy, Formal Logic;—Part 4—The Philosophy of Investigation, Grammar, Rhetoric, Ethics, Law, and History. The four Parts were printed in Sanskrit and English.

In the course, above referred to, of lectures to this class of pandits, I followed the division of the sciences adopted by Dr. Arnold in his address to the Rugby Mechanics' Institute,—

"But when we arrived at the questions of Metaphysics, the consideration of which I had sought to postpone until we should have gone amicably over some less debateable ground, and thus perhaps have obtained some previously established matter to serve for reference to when illustrations were required, my auditors, accustomed to that strictness of methodical arrangement which is so attractive in their own systems, immediately began to object, (like Demetrius, in the play, to Moonshine with his dog and his thorn-bush—) 'Why, all these should be put in the lantern:'—in other words, that what in Europe is treated as a branch of science, under the name of Metaphysics, ought, with some fitter name, to furnish, like their own *Nyáya*, the framework of the whole of the sciences. Having foreseen this objection, I stated to my critics my reasons for having adopted a different order in addressing them, and mentioned my hope that there might be furnished, for the satisfaction of those who felt interested in the preliminary course, a fuller exposition of the sciences, with an arrangement modelled on their own."

The Synopsis to which these recapitulatory notices are introductory is an attempt to redeem the pledge thus given. Its principle of construction will be the better understood from the perusal of an extract from the Minute of Mr. M'Leod on the examination of 1848-49. In that Minute, Mr. M'Leod recommends attention to the Report for the year,—

"More especially as, in conjunction with those which have immediately preceded it, it developes the principles and gradual progress (in its application) of what I believe may be considered as an almost entirely novel theory of education, as applied to India, or any other nation similarly circumstanced in respect to its instructors, or at all events one, which in one important respect differs greatly from that which prevails in our other educational Institutions generally.

"Those who have heretofore had the direction of Educational measures in this country—whether on the part of Individuals, Associations, or the Government, appear to have acted for the most part on the principle of regarding the Hindoo mind, for all practical purposes, as a 'tabula rasa' in respect to any preconceived ideas, and pre-established system of literature, philosophy, or science either useful and valuable in themselves, or esteemed such by the people with whom we have to deal. and the effects of this appear to me to have been highly prejudicial in many ways; as I think a survey of the general results at our presidencies, as well as elsewhere, will satisfy most candid observers.

"It has tended to segregate from the mass of their countrymen the elêves of our Schools and Colleges; and these, finding that they have no longer ideas in common with those of their brethren who have not been similarly educated, but are rather contemned by a large portion of them, at the same time that they are conscious of being more favorably regarded by the members of the ruling nation, and more nearly assimilating to them in sentiments, have very generally evinced a disposition to regard the former with contempt, and to imitate the least commendable of the peculiarities of the latter; a self-sufficient assumption of superiority taking the place of the humility which a mere entrance within the portals of the vast field of knowledge might be expected to produce. It has also greatly incapacitated these youths for the task of communicating to their countrymen the knowledge which they have themselves acquired, even if other circumstances favored the endeavour; so that except to whatever extent circumstances may in any locality have given extension to the direct study of English, little or no progress has as yet been made towards inoculating the mass with the knowledge of the west, and lastly it has entirely repelled from us, by wounding their self-esteem and pride of learning, those classes who possess, and who, unless their position be more strategetically stormed, I doubt not will yet long continue to possess almost unbounded influence over the large majority of the nation."

Mr. M'Leod goes on to express his hope that, by carrying out the system laid down in the report, the unsatisfactory state of things then existing may be reversed; that "the student of the European school may be brought to understand, appreciate, and sympathize with the Oriental scholar, and the latter with the former," that "the analogous or identical truths of the systems respectively pursued by each may be traced out and established as common starting points," and that thus the learned

Hindús "may be conciliated and gradually won over to our cause, and their great erudition and philosophical training brought to bear with effect and power upon the researches which we most value." These sentiments of Mr. M'Leod, most accurately embodying the drift of the Report, will suffice to explain the general aim of the following Synopsis. Why the aim has been taken exactly as it has been, it remains to explain.

In the Report for 1849-50, speaking of the English class of pandits, I remarked that—"Aided by these men I shall now listen with simple disregard to the discouraging reiterations of those who insist that the truths of science and of philosophy cannot be communicated to the Hindús without the use of words which would go to barbarize their language; as if a language richer in roots than any European one, and far more finely organized, could not supply as many available terms;—as if the Sanskrit needed instruction at the hands of its grandchild the Greek. To render intelligible our plan of operations for the next session, I may here remark that my first attempt to open a communication with the frequenters of the Sanskrit College was made in the shape of a set of lectures on the Circle of the Sciences. The Sanskrit version of these was carefully revised by Pandit Bápú Deva, whose rendering of many of the scientific terms was most felicitous. I learn that these renderings have been incorporated into the English and Sanskrit Dictionary now preparing by Professor Williams for the use of the College at Haileybury. In those portions of the lectures which related to sciences which the pandit had not studied, we were less successful than in the others. To ensure success it would have been indispensable to investigate the first sources of the nomenclature appropriated to the same or kindred topics in the Hindú Philosophy, and how I propose that this shall be done, I now proceed to state.

"The multitudinous treatises in the six great schools of Hindú Philosophy are all based upon, and are held to be of authority only in so far as they coincide with, the six collections of Aphorisms promulgated severally by the founders of the six schools. The aphorisms were intended not to convey the doctrine but to record it,—hence their oracular brevity. They resemble, in some measure, such formulæ as that of the Binomial Theorem, which, when once explained, enables one to recollect readily a complicated series of facts which—if expressed in words at length—no human memory could have retained a knowledge of." The Aphorisms, therefore, from the first, had been attended by a comment, oral or written; and, with the aid of these, it was now proposed to make a critical examination of the original Aphorisms, because, "only by tracing the development of Hindú thought, and of the terminology in which it clothed itself, can we hope to avoid completely all such misappropriation of terms as that which has, to a certain extent, baffled all European attempts at translation into the Hindú dialects wherever the subject of discussion transcended the palpable."

It has been already remarked, that, of the Hindú systems, the Nyáya is the one which lends most readily its arrangement and terminology for the conveying of new scientific information intelligibly and satisfactorily to a learned Hindú. Whilst, therefore, the translation of the several systems has been carried on simultaneously,—each system supplying terms and views which will be turned to account,—it was the arrangement of Gautama's Aphorisms that was adopted as the frame-work of the proposed Synopsis. In his 1st Book (—which, along with the 1st Book of the *Vais'eshika*, the *Mímánsá*, and the *Vedánta* Aphorisms has been printed with a translation for the use of the College—) Gautama lays down the plan of the whole Nyáya system. This he effects in sixty Aphorisms. He starts with the grand question of questions—the enquiry as to how we shall attain the *summum bonum*—the "chief end of man." This he declares, in his 1st Aphorism, can be reached only through knowledge of the truth. But have we *instruments* adapted to the acquisition of a knowledge of the truth? We have our senses &c., and these Gautama enumerates and describes in Aph. 3—8. But, if we have instruments, let us know

[Other portions have been since brought out.]

But the bare enumeration and definition of objects does not ensure correct and believing knowledge of them The state intermediate between hearing and believing—viz. doubt—he defines in Aph. 23 But how is a man to get out Doubt? He will be content to remain in doubt if there be no *motive* for enquiring further. Here—Aph. 24. he takes occasion to explain what constitutes a Motive. But in every enquiry, to reach the unknown, we must start from the *known*,—there must be *data*. These he describes and classifies in Aph. 25—31. The data being determined, it is proper to determine the order of procedure in demonstrating thereby something not granted. This he sets forth in Aph 32—38. But, thus far, we have been shown an arrangement for hearing only one side of a question, and how can we be sure that the opposite side is not the right one? The propriety of hearing both sides of a question before making up our minds GAUTAMA suggests in Aph. 39-40. But an honest enquirer may have heard both sides and still be in perplexity Is he to be turned adrift? Not at all. Candid discussion with one who holds the same first principles is open to him,—Aph 41. There are yet others, besides honest enquirers, that are not utterly to be rejected A person not hopelessly irreclaimable, may *wrangle* for the sake of a seeming victory. In Aph 42, therefore, he defines wrangling, A person, still perhaps not hopelessly irreclaimable, may descend lower than the former by carping at others without undertaking to settle anything himself In Aph 43, therefore, he defines cavilling. Wranglers and Cavillers, in default of good reasons, must make use of *fallacies*. The various forms of Fallacy, therefore, he defines in Aph. 44—49. But whilst there are fallacies by which a man may deceive himself as well as others, there are *frauds* which are employed only dishonestly for the deception of others. These he describes in Aph. 50—57. Descending a stage lower, an opponent may employ objections so futile as to be capable of deceiving no one. It is well to know in what consists the futility of such objections This he shows in Aph. 59. Finally an opponent, sinking even below the former one, (who *knew* what he was opposing, though he could make none but a futile opposition), may be unable to understand the proposition,—Aph 59—60 Here GAUTAMA's patience is exhausted, *but not before* Against everything but the invincible combination of the spirit of contradiction with *stupidity*, he seeks to arm himself at all points. An objection the most frivolous—or even futile—provided it be tendered by one who understands the proposition—he does not refuse to deal with. The objection might perplex some honest enquirer, and therefore GAUTAMA, or the follower who has imbibed his spirit, does not consider himself at liberty to consult his own ease by scouting it, though he himself may see its futility plainly enough. It is fair to remember this when we meet with ludicrously frivolous objections gravely treated in a Nyáya work. The author is not to be supposed to have *invented* the objection It was offered to him—offered very possibly for the purpose of vexatiously puzzling and perplexing,—and the Naiyáyika will not allow himself to be puzzled and perplexed. The most cavilling opponent is not to be allowed the semblance of a victory; he shall not be allowed to boast even of having put the philosopher out of temper. This single triumph—such as it is—is reserved for the absolute blockhead.

Now, I should be glad to learn from those who undervalue the *method* of the Nyáya—speaking of its exposition as "tedious, loose, and unmethodical"*—how could that method be much improved? One must not imagine that he has answered this question when he has shown that there are some important matters not here explicitly noticed by GAUTAMA. He must be able to show either that there are important matters for which the system provides no place, or that the order of procedure is misarranged. The order of procedure, according so my own view of it, I have explained. The enquiry whether there is anything within the range of conception, for which the arrangement above sketched does not furnish its appropriate place is one to which we aim at giving a practical reply in the Synopsis now commenced.

* Ritter's History of Philosophy—English version—vol. iv. p. 366.

Meantime let us take a cursory glance at the range of topics whi be necessary to deal with in preparing a consistent digest of European k the use of India.

Knowledge may be subdivided, at the outset, into that whicl ted by Revelation, and that which is searched out by Philosophy latter branch that we must at present be concerned. The knowledge out by Philosophy constitutes Science, and, when applied to the attainment of the ends, it gives rise to Art. Science relates to things that exist as realities, or to their modes of existence What exists as a reality is either Matter or Spirit. The modes of existence, as Number, Magnitude, and Motion, give rise to such sciences as Arithmetic, Geometry, and Mechanics. Matter may be regarded as Imponderable or Ponderable Imponderable matter presents itself in the shape of Heat, Electricity, and the like Ponderable matter may be regarded either as in Atom or in Mass. In Atom, it furnishes the object-matter of Chemistry. Viewing it in Mass, we have the earth either considered in connection with the heavens, by Astronomy, or considered alone; superficially, by Geography. or as to the causes of the existing distribution of its parts, by Geology, or in regard to its constituent masses. These are either Inorganic, in which case they belong to Mineralogy, or Organic, the latter division including the Vegetable and the Animal kingdoms Vegetables are considered structurally in Botany, and functionally in Vegetable Physiology. Animals are considered structurally in Zoology and Anatomy, and functionally under the two physiological conditions of health and disease,—conditions with which the science of Medicine is conversant.

Reverting to the other main branch of the division,—Spirit may be divided into the Supreme Soul, or God, and the Human Soul. Considered as a philosophical question, apart from revelation, the question of the existence and the attributes of God furnishes the topic of Natural Theology. With regard to the human soul, there arise four questions We may enquire into its nature and operations, as questions of Psychology; an enquiry with which it is customary to associate the enquiry into Being—or the science of Metaphysics Secondly, we may enquire into the duties, of the soul, or of its possessor. This gives rise to Ethics, private and public. Thirdly, we may make separate enquiry respecting the instruments of the soul—Language, Inference, and Exposition Language belongs to Grammar, Inference to Logic, and Exposition to Rhetoric. Inference again is either of generals from particulars, or of particulars from generals, so that Logic is either Inductive or Deductive Fourthly, Soul, or its possessor, may be regarded as the agent in the events of History; and this may be regarded either as matter of fact, or as something calling for an exertion of the critical faculty. Viewed under the former aspect, it may be subdivided into Political, Religious, and Philosophical Considering it critically, we have two questions to ask,—firstly, what are its credentials, and lastly what are its lessons

Assuming that this enumeration includes the topics of a complete liberal education, I am desirous that the whole digest, of which this Synopsis seeks to indicate the starting-points, shall be prepared, in the first instance, with reference, as close as may be, to one of the systems of the universe already current among, and accepted by, the Hindús. In explanation of this, I would beg the reader's attention to the two facts, that a mind can be taught only by means of the knowledge that is already in it, and that a piece of knowledge in any mind—more especially in a mind unfavourably prepossessed—is an obstacle to the reception of any system which, by neglecting to recognize, appears to deny, the truth of that piece of knowledge.[*] Whatever in

[*] The scheme of treating the Hindú mind as a tabula rasa, ignoring the existence of Hindú opinions right or wrong, and of attempting to educate India solely by means of the English language, I of course regard as unfeasible. The hopelessness of this somewhat indolent and much too supercilious scheme has been shown by Mr. B. H. Hodgson, in his letters on Indian education, with a clearness that might convince prejudice itself. Let there

the Hindú systems is a portion of the adamantine truth itself, will only serve to baffle our efforts, if, in ignorant impatience, we attempt to sweep it away along with the rubbish that has encrusted it. What kind of engineer should we think him, who, when seeking to raise a beacon on the Goodwin sands, should hesitate to acknowledge as a god-send any portion of solid rock, amid the shifting shoals, to which he might rivet one of the stays of his edifice? When a headstrong opponent of an imperfect system treats with indiscriminate scorn what is true in it and what is false, he has no right to complain that his arguments against the false are as lightly esteemed as his scorn of the true. When the Hindús have only halted at a stage short of that which we ourselves have reached, we should rejoice in being able to present to them our superior knowledge as the legitimate development of what is true in their views, and not in the shape of a contradiction to anything that is erroneous.

It is with such aims that I have made use of the Nyáya system as the framework of the following Synopsis. Wherever in the 1st Book, I have been constrained to dissent from GAUTAMA, I have recorded the amount of divergence in a note. The English reader will perhaps be surprised to find in how few instances I have considered it necessary to record dissent. He may probably think that I ought to have done it in more; but, in regard to this, I trust I shall be able to satisfy the attentive reader as the work proceeds. The style of the commentary will strike the English reader as stiff and ungainly. If he will compare it with the translation of GAUTAMA's Aphorisms which is interspersed with native comment, he will see that I have intentionally imitated the established style of exposition. My object was, not to introduce a new style, but to convey truth in the style which, as being the established style, was the least likely to provoke cavil

After completing the first Book, containing the plan of the whole system, I did not consider myself bound to follow the order of GAUTAMA in the development of the matters therein propounded. Having come to an agreement with my Hindú readers as to how much of the first Book we jointly accepted, the development of the accepted portions might of course, without detriment to the mutual understanding between the parties, be carried out in such order of succession as circumstances should render advisable.* Now it happens that the Nyáya philosophy, though furnishing a framework for an encyclopedic body of doctrine, has, in practice, confined itself very much to the topics of Logic and Metaphysics, to the neglect of the topics of Physical Science. This defect it appeared desirable to remedy in the first instance, and, accordingly, my 2nd Book,[†] after a concise account of the Five Senses (in regard to which some erroneous opinions of the Hindús are there corrected), proceeds to treat of "Matter, or that—the qualities of which furnish the objects of the Senses." This leads to Astronomy, Geography, &c. These Sciences are here treated very briefly, because, as I intend the Synopsis to be employed by the Nyáya Professor, and to furnish for his pupils a comprehensive view of the relations of all the principal sciences to the philosophical system of the Nyáya, the main design would be obscured if each topic were treated much more fully. For the use of the other classes respectively I intend that each of the sections in the Synopsis,—on Geography, Chemistry, Mechanics, &c., shall form the starting-points of more expanded treatises. The completion of these would require such resources as those of the College of Translators which Mr. B. H. Hodgson has designed, and which I shall not despair of seeing established. In urging the advisableness of preparing a carefully systematized body of instruction, it is of course implied that the irregular and immethodical plan hitherto followed for supplying the desideratum does not appear to me calculated to produce effects correspondent to the labour thus immethodically expended. The plan hitherto has been to say, "Here is a good book—let us trans-

be as much English education given as possible,—the more the better;—but let not the delusion be cherished that we shall then have done our part.

[†] [In this second edition it has been thought advisable to arrange the Sciences in closer accordance with the order followed by Mr. Whewell and M. Compte.]

late it." And so a considerable number of books has been translated, and still the want is far from being supplied,—just because no moderate, much less any undigested, selection of books can give the quintessence of the Library of Europe. One book intrudes largely into the province of another; and when this is not attended to, we go on reproducing the same thing over and over again, sometimes in a better shape and sometimes in a worse, and the consequence is, that, while our toil is multiplied, our readers do not add to their knowledge in proportion as they proceed with their reading. The evil of such a state of things in Europe is attempted to be remedied from time to time by the issue of Encyclopedias, which undertake to sum up the total of real knowledge up to the date of publication. The adoption of such a comprehensive method at the outset would have saved, in Indian education, a world of time and expense. It is not too late to adopt it in regard to the Sanskrit, in which hitherto next to nothing has been done to make those conversant with that language acquainted with European Science.

To a reader who is not aware of the relation—the still *existing* relation of the Hindú languages to their living and fostering parent the Sanskrit—the only parent to which they can look up for wholesome nourishment[k],—it may seem paradoxical when I assert that the fit preparation of a version of any scientific treatise in Hindi, Bengalí, Mahratta, Guzeratí, Támil, Telugú, and Sanskrit, is easier than the preparation of the same set of versions without the Sanskrit one. A little reflection will show that there is nothing strange in this. What is the difficulty—the transcendent difficulty—in translating a European work into an Oriental language? It is the difficulty of determining the exact amount of correspondency between the different portions of the knowledge, on any subject, elaborated by the East and West, and embodied

[k] In regard to this point I may transcribe the following observations from an article on 'The Prospects of India, Religious and Intellectual' (Benares Magazine, March 1849,) various portions of which, as conveying opinions which I have seen no reason to change, have been incorporated in the present Advertisement.

"It is a great and mischievous mistake to regard the Sanskrit in India as a dead language, in the sense which that term generally suggests. What is meant by a dead language? Nine men out of ten will reply at once that it is a language no longer spoken by the people as their mother-tongue. This definition at once suggests to six men at least out of ten, the idea of a language, the cultivation of which, if desirable at all, is so mainly as a matter of intelligent curiosity. But a very little reflection will suffice to convince any one that of the languages which, in terms of the foregoing definition may be called dead, by no means the whole fall under the description here suggested. For example, the Anglo-Saxon is no longer spoken by the people of England, and neither is the Latin. To call them both dead languages, however, does not fairly imply that their claims to attention are equal. In respect of their influence upon the spoken language of the day, the Anglo-Saxon, from which, either as a language or a literature, we have long since ceased to gain anything new, may be regarded as the deceased parent of the English; whilst the Latin, from which our language receives yearly accretions, and by whose literature the minds of each successive generation are moulded, acts the part of a living nurse—though we may choose to hold it technically dead. But if the difference be great between these two, which is hidden under the general name of "dead language," much more momentous is the difference which can slip fallaciously out of sight when the same conveniently loose cloak of a generalization based on the non-essential throws its misty folds around the Sanskrit also. The Sanskrit, to all intents and purposes of any consequence, is no more dead than our reader, who would be able to insure his life on his own terms if he could show that he had the slightest chance of surviving it.

In the Dedication prefixed to the first Edition of his Dictionary, but omitted in the second, Professor H. H. Wilson remarks:—

"The value of the *Sanskrit* language, as an object of literary curiosity, is of no moment compared with its importance in the light in which it must be viewed by all who duly consider its connexion with the welfare of this country"

That is an important testimony from a scholar whose tastes and acquirements would tend to anything rather than to make him underrate the value of a thing "as an object of literary curiosity" compared with its value in any other point of view.

in their respective forms of speech. Different philosophic or scientific theories give rise to different forms of expression; and, where this is disregarded or forgotten, we have the story of Babel repeated indefinitely Now, this immense difference of cast, both in thought and expression, meets us in every Indian language which we try to make the vehicle of our knowledge; but if the work which it is wished to communicate to all India is once put fitly into Sanskrit, the task is well-nigh done. There is little more difficulty in turning the Sanskrit work into each and all of the vernaculars, when there are properly instructed pandits of all nations at hand, than in turning so many ingots of gold into guineas, sovereigns, and half sovereigns, when the mint is at your command. When a book has been first rendered into unexceptionable Sanskrit, the risk of error, under proper supervision, is at an end, whereas, if translations are made into each language directly from the English, the risk of misconception perpetually recurs. A correct Sanskrit version is like the golden or platina rod deposited in the exchequer office, by which all the brass and wooden yard-measures in the country can be verified, or rectified. To obviate misconception, it may be proper to add, that I wish the Sanskrit version to be regarded as the measure and criterion of the *sense*, not as the rigid examplar of the *form* to be adhered to in the vernacular versions to which it shall supply the matter and the scientific terminology.

As it is in the Nyáya class that the Synopsis is to be employed, there is one section of it which I contemplate treating more fully, in the first instance, than the other sections,—the section, namely, of Logic, Ratiocinative and Inductive. In the Sanskrit Lectures on the Mutual Relations of the Sciences, I furnished the Nyáya pandit with a concise exposition of the European theory of the Syllogism; and his pupils, while studying it, were not a little struck with the technical apparatus of "Barbara, Celarent, &c." resembling so closely as it does, in its employment of indicatory vowels and consonants, the time-honoured technical apparatus of the Sanskrit Grammar In a sketch of "The Philosophy of Investigation," I adopted, from Sir John Herschel's Discourse, the fine example of Induction furnished by Dr Wells's theory of the formation of Dew. In constructing both of these tracts in Sanskrit, I found it very difficult to satisfy the pandits. The fact being that they had a system of their own, unless all the terms were employed in strict accordance with that system, continual misconception was inevitable Our modern conception of Induction being that to which is particularly to be attributed our superior progress in science, it appeared highly important, since there existed such a difficulty in coming to a mutual understanding, that the Hindú speculations on the subject should be carefully investigated; and I was therefore glad at this time to receive from Professor H. H. Wilson a letter suggesting that a translation of the *Anumána Khánda*, or "Section on Inference," the standard treatise on Hindú Logic, would be very acceptable to the logicians of Europe. An examination of the work in question showed me a greater resemblance than I could have hoped to find between the turn of thought and expression in the writer and in Mr. John Stuart Mill, whose work, on "Logic, Ratiocinative and Inductive," I had begun to employ, with good prospect of advantage, in reading with my class of pandits Two treatises have therefore been commenced, and put to press:—the one to consist of such a commented abstract of Mr. Mill's work as may best suit at present the class of readers for whom it is intended,—and the other, of a translation of the parallel Sanskrit treatise above mentioned, on the same subject, to be studied in the English department also of the College.

For the use of the students in the English department, I prepared, as a sequel to the Lectures on the Nyáya Philosophy, a Lecture on the Sánkhya Philosophy, embracing the text, with translation, of the *Tattwa-samása*, and a Lecture on the Vedánta Philosophy, embracing the text, with translation, of the *Vedánta-sára*.*

* In the preface to this translation it is remarked as follows:—"That this exposition of the most abstruse of the Hindú systems should be faultless, is very far from probable. In bringing it—as it now stands—before the senior English students, and the class of pandits, in the Benares College, who have for some time been studying English, the intention is-

# THE FOLLOWING IS A TRANSLATION OF THE

## SANSKRIT PREFACE.

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That intelligent persons should differ in opinion on any matter of importance is cause of regret. It is another cause of regret that intelligent persons should imagine that they differ in opinion where they really do not differ. How much of useless altercation or of unjust censure is likely to result from such mutual misapprehension, it would be superfluous to insist upon. It can never be an unworthy aim to endeavour to remove any mutual misapprehension which tends to make even two individuals think unworthily of one another: how much less so, then, where the mutual misapprehension exists between two great sections of the earth's inhabitants. The attempt is one in which even to have failed may be no disgrace.

The Hindús have an ancient literature which they cherish with affectionate pride. In this they do well. Europeans have a literature for which the praise is claimed that it is daily adding to the intellectual wealth of mankind. If Europeans regard their literature, in this aspect, with an affectionate pride, they also do well. But if the European, not rightly perceiving how the Hindú is asserting some unquestionable truth, in phraseology to which the European is unaccustomed, shall condemn the Hindú as asserting an error, he unknowingly commits injustice; and the Hindú is liable to commit the like injustice in return. This liability to mutual misapprehension being very undesirable, it is desirable that a remedy for it should be devised.

As two opposite opinions cannot both be right, and as there can be no good, and there may be much harm, in holding a wrong opinion, it is reasonable that intelligent men, when they differ in opinion, should amicably discuss their difference. This, however, cannot be satisfactorily done unless they clearly apprehend what their difference amounts to; and as difference commences where agreement ends, it is desirable in every case to determine as accurately as possible how for the agreement extends, in order that we may not be liable, in the heat of argument, to dispute about that which is not a matter of disagreement.

Having resolved, therefore, to attempt to determine the extent of agreement between European and Indian thinkers, it became a question what exposition should be assumed as most fully and fairly representing the sentiments of the Hindús. There was no difficulty in selecting the Nyáya in the first instance, because this system of philosophy, while it adverts, in some way or other, to all the topics considered in the other systems, takes cognizance also of various matters which the other systems disregard. Although other systems of philosophy, besides the Nyáya, are accepted in India, yet it suffices if we determine how far the sentiments of Europeans accord with those of the Nyáya; because, if a reader knows what relation the Nyáya bears to the Sánkhya or the Vedánta, with which he holds the Nyáya to be reconcileable, he must understand the relation of European philosophy to each of the other two if he understands its relation to this one. He who already knows the relative bearings of the three great places of pilgrimage, *Kásí*, *Gayá*, and *Prayága*, should be able to estimate the bearing of the second and third of these in respect of any fourth city, if he knows how that city lies in respect of the first.

In the first book of his Aphorisms, *GAUTAMA* lays down the plan of the whole Nyáya system. The reader to whom the present work is addressed is supposed to be conversant with the first book of the Nyaya Aphorisms. Such a reader will at once see how far we agree with GAUTAMA, and in regard to what points we differ from him. It has been thought advisable that, after determining thus much, we should then, instead of discussing the points of difference, rather go on to the developement of the points of agreement, in the hope that, in the course of such an enquiry, the points of difference may either disappear or may have such light thrown upon them that we may be the better prepared to deal with them.

It has been the endeavour throughout to make the expositions as simple as possible, but the reader who is unacquainted with European literature must not be surprised if he meets here some things hard to understand. Almost every treatise on any novel topic requires to have light thrown upon it by an oral instructor. The reader, therefore, where he does not clearly see the sense, will do well to enquire of some one competent to explain and illustrate, rather than lay aside the book with the conviction that it is unmeaning because the meaning is not at once everywhere clear to him. It is in particular difficult to convey, by means of words alone, an adequate conception of such facts as can be best exhibited by experimental illustration.

A fasciculus of the excellent text-book of the Nyaya employed in Bengal has also been printed, with a translation, for the use of the English pupils, and, to smooth the entrance to the grammar, I have prepared, with the aid of Mr Hall, a series of "First Lessons in Sanskrit" on the method of Ollendorff, each sheet as it was printed being supplied to the classes. By such means we aim at rendering Sanskrit, with all its fine capabilities as a disciplinal study, no longer a thing here attainable only at the expense of a life-time; and it is thus that we aim further at making the English and the Sanskrit departments of the College understand each other on subjects in regard to which hitherto the students of the two departments, though speaking the same Vernacular, could as little understand each other as the inhabitants of separate planets with separate natural laws. The reader unacquainted with the facts may find it difficult to conceive this—I give him my word for it. Another standard work, the treatise on literary criticism entitled the *Sáhitya Darpaṇa*, has been selected as a portion of the course of Sanskrit study designed for the English department. The printing of this work, with its translation, as the subject seemed likely to interest European scholars, has been undertaken by the Asiatic Society, and the first fasciculus is now published as a portion of the 'Bibliotheca Indica' I trust that in due time the whole of the course of study pursued in the Sanskrit department will become by such means opened to the pupils of the English department, and I am not without hopes that when this shall be the case, a collateral result will be the removal (from the minds of those competent to judge) of a considerable amount of misconception at present existing in regard to the nature and value of a Sanskrit education. The Oxonian who rightly esteems Aristotle will not disesteem Gautama and Siromaṇi when he becomes equally well acquainted with them

In the Benares College,—besides the Arabic and Persian department, which does not come within the scope of the present notice,—there is another department not yet adverted to, viz, the Hindí According to the native system the young Brahman is confined to the study of the Sanskrit grammar for a protracted period before he learns anything besides the sounds and inflections of words. This arrangement being objectionable, the younger students of Sanskrit are now formed, during certain hours of the day, into classes for the study of various matters of useful knowledge, such as Geography, Arithmetic, Mensuration, &c, in their vernacular Hindí. The various Sanskrit works rendered into English for the other department are to be rendered also into Hindí for the use of these students, and some progress has been made in this direction.

Such,—as regards the enlisting of the Sanskrit on the side of progress,—is an outline of what has been attempted, during the last five years, in the Benares College. It was scarcely to be wondered at that a line of operations such as I have sketched,—designed to make the learning of the Hindús a strong ally instead of a stubborn opponent,—should occasionally be mistaken for a fond admiration of Sanskrit scholarship and an injudicious undervaluing of everything else in comparison. To show that this is quite a misconception, enough has been now said.

*Benares College,*
31*st July*, 1851,

J. R. B.

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..ludes its being submitted to a searching criticism, so that any errors entertained in regard to the system, by Europeans, may have the better chance of being discovered and rectified." The same remark applies to all my other translations. Though no pains has been spared on them, and they are the result of labour curiously disproportioned to the smallness of their bulk, yet I do not presume to offer them to the scholars of Europe except as *proofsheets* awaiting correction.

The reader, if he be, as is not improbable, fond of abstract speculation, such as is found in the logical sections of the Nyáya, ought not to regard with impatience the discussion of facts in regard to the properties of material things, to which we have seen fit to devote certain chapters, because, unless we have an ample body of recognised facts, it is impossible properly to exemplify and justify the logical processes of scientific enquiry which furnish the subject of certain other chapters. If, on a hasty glance, it should seem to him that the discussion of wheels and hammers and ropes is beneath the dignity of philosophy, we would remind him that his own revered teachers of Astronomy give to the learner his first conceptions of the arrangement of the heavens by means of an armillary sphere formed of little hoops of bamboo, and that the Indian logician has not disdained to study the wheel of the potter, though he has not yet learned from it all that it is qualified to teach.

# PREFATORY REMARKS

ON

# TRANSLATION.

Since the publication of the first edition of this Synopsis, the Despatch of the Honourable Court of Directors, of the 19th July 1854, ordaining a great extension of the means for the education of India, has given fresh interest to the question how the books to be employed in carrying out the work of enlightenment and civilization ought to be constructed. Terms of constant recurrence in discussions like the present are "Education," "Schools," "India," "The Vernacular," "Native Learning," Let us look at each of these in turn

*Education what.*

Education is too generally held to be synonymous with professional training When a man holding such a view, and looking on the professionally trained pupil merely as an available instrument, speaks with another man who holds the pupil to be not a mere instrument, but an end in himself, the colloquy must prove highly distasteful to both. Education is the educing, or eliciting, the faculties of the pupil, with a view first to his own benefit,—and this not necessarily without a view to the benefits which such an educing of the pupil's faculties may incidentally, as it will most probably, procure for others. Education, thus viewed, admits of wide differences in degree.

*Schools not all upon the same level.*

Different degrees of education are to be given in different kinds of schools. In the highest of our schools it would be disgraceful to us if we did not endeavour to teach whatever thing of value we are competent to teach In respect of the lower schools, down to the Ragged School of the poorest village, we shall be more likely to advance the good work if we begin by determining what shall be imperatively included in the course, rather than by deciding what is to be imperatively debarred admission In a small provincial school we need not undertake to teach Berzelius's System of Chemistry, in its five thick octavo volumes, but there is no reason why the name of "Chemistry" or Science," should deter us from attempting to teach such matters of the Chemistry of Common Life as the fact that Air is necessary to the burning of a lamp, and the reason of this, how the burning lamp-wick is not annihilated, seeing that we can, with apparatus no more complex than a glass-tumbler, catch the invisible products of the combustion, and demonstrate their existence, the theory of rusting, and why rust is prevented by oiling; the processes of solution, filtration, evaporation, and crystallization, exhibited with the aid of small portions of the salts procurable in the bazaars; or the theory of the whitening of lime water by breathing into it,—thus unveiling the trick of the religious mendicants who profess to turn water into milk by their muttered spells. Things such as these could be profitably taught in very elementary schools. In the higher schools, of course, more is to be expected and demanded.

*India not to be mistaken for a homogeneous unit.*

But it is education in the schools of *India* that we are speaking of, and it is needless to hope that the huge heterogeneous aggregate can be educated by means of some one common language, termed "the Vernacular." To come to a clear understanding on this matter of the Vernacular, it i necessary that we should previously gain some clear conception of Native Learning and of the native learned.

*Native learning, and the native learned.*

The native learned may, for our present purpose, be divided into those for the discipline of whose mental faculties the gymnastic was furnished by the Arabic, and those for whom, on the other hand, it was furnished by the Sanskrit. Of really learned Arabic scholars, who study Sanskrit, or of really learned Sanskrit scholars, who study Arabic, I have met with no instance among the natives of India. These two languages, in the hands of those who severally are really masters of them, are the feeders of the two great vernacular streams,—viz., the Urdú, fed from the Arabic, and running its undivided course, the other stream, fed by the Sanskrit, and branching off into the Hindí, Bengálí, Mahratta, Guzeratee, and their kindred tongues. And not only is the Sanskrit the feeder of these streams, but it feeds also the radically different Tamulian languages of Southern India,—because the teachers there are Brahmans, who owe their mental training to the Sanskrit. On a hasty view, it might here seem to offer itself as a legitimate question, whether, on this showing, the Arabic or the Sanskrit were of the greater importance. Such a question I simply refuse to entertain. The question is as much to the purpose as the question whether beef or hay were of the greater importance when you had to feed men and horses.

*The question as to the comparative importance of the Arabic and of the Sanskrit here a purely mischievous one.*

*General preference of the Arabic accounted for.*

As a feeder of "the Vernacular," the Arabic is apt to be regarded, by the generality of persons in authority, with greater favour than the Sanskrit, because, from circumstances, the public offices are what we may term Persianized. During the period when Persian was the only language of the law-courts, Arabic was studied, and rightly, as the indispensable basis of any real knowledge of modern Persian. Persian has now long been discontinued in the courts, but the Urdú substituted for it is little else than the same Persian with Indian connectives substituted for the Persian ones. The cultivators of Arabic and Persian have thus continued to blockade the courts, and so the European officers are liable to intermingle with their vision of the outside world something of the Arabico-Persianized medium through which their native subordinates habitually communicate with them. I would find no fault with any amount of esteem for the Arabic and the Persian,—each of them long ago the object of my own ardent study and admiration,—if this did not lead,—as it too frequently, and most unreasonably, does,—to a disparagement of the uses of the Sanskrit. As I have already stated, I simply refuse to recognise the question, which is of the greater importance,—Arabic or Sanskrit. Both are indispensable.

*What the value of native learning consists in.*

As regards our educational proceedings, the importance of Native Learning is not to be measured by the value,—real or supposed,—of the amount of information contained in the Arabic and in the Sanskrit. The disparagers of the one or the other literature will scarcely be found among those who really possess any knowledge of either. The best judges have long ere this decided, that the Arabic and the Sanskrit languages are noble disciplinal studies, and that they are fountain-languages, from which the vernaculars can be indefinitely supplied with fresh forces. But, in order that the fresh additions may become naturalized, it is indispensable, first, that the additions should be made by persons thoroughly qualified to make them rightly, and secondly, that the learners should have access to complete information respecting the reasons why each particular addition was made exactly as it was. In other words, a permanently vital system of education, in modern science, through the medium of un-barbarized Urdú, implies the possibility of reference at all times to learned and well-informed Maulavís, and, analogously, in the case of the Hindí dialects, to learned and well-informed Pandits; just as a scientific English education implies the possibility of reference to reliable sources of information relative to the classical languages from which the terms of science are taken in Europe. Where this access to the fountains is not open, or not made use of, the terms will be found to degenerate rapidly into a gibberish,—such as we find in the *digarí* of our law-

courts, for a "decree," the *tárpín-ká-tel* of our laboratories, for "turpentine," or the *mámlet* of our kitchens, for an "omelette."

*Through what practical agency India is to be educated.*

If these views are just, then the first question which requires to be distinctly settled is whether we are going to undertake the education of the Indian millions through an English agency, or through a Native agency. The idea of its being possible to employ a direct English agency in the tuition of all India, is perhaps explicitly entertained by no one, but the legitimate consequences of the impossibility are very liable to be over-looked. The labour and difficulty of reproducing,—really, and not merely in fallacious appearance,—European terms of science in the languages of the East, originate a kind of indolent impatience, which seeks to cut the Gordian knot by deciding that the English language ought to be the language of science for all the world,—a decision recommended by the plausible plea that a cosmopolitan language of science offers obvious advantages. My reply rests on the fact, which I have asserted and illustrated, that scientific terms cut off from the possibility of reference to their sources, tend headlong towards degeneracy. Under a complete English agency employed in the tuition of all India, this natural, and experienced, result, might be partially staved off; but with the agency which, as already agreed, we must go to work with if the work is to be done extensively at all, the English names will rapidly alter to such a degree that no one who has not watched the progress of their degeneracy will be able to recognise them; and thus the fancied advantages of a cosmopolitan terminology vanish.

*The hope of a cosmopolitan terminology chimerical.*

The degenerated English terms of our law-courts, our laboratories, and our kitchens, are just as unintelligible to the new-comer as if they were native terms which he had never before met with A shout of laughter usually accompanies the discovery of what the transmogrified vocable was intended for; but the word is no help towards mutual understanding The same would be eventually the fate of an English scientific terminology in the hands of the only agency which, by the hypothesis, is at our disposal for the education of the millions.

Having set forth reasons for holding that an extended vernacular terminology, to have any chance of becoming profitably naturalized, must be fed from the sources of the Arabic or of the Sanskrit,—and having explained my conviction that neither of these separately can be made,—except in most delusive semblance,—to supply the place of both, I should now proceed to exemplify the application of an Eastern fountain-language, the Sanskrit, to the production of new terms of science;—but before entering upon the terminology of the sciences, I must state my reasons for taking these in the order in which I take them.

*The end and the means in the attempt to educate India, ought to be clearly determined.*

In designing an educational course, if we are to go to work methodically, systematically, and profitably, then regard must be had to the end and to the means Where no distinct end, or not the same end, is kept in view by those who take part in a discussion, agreement as to the means is pretty well out of the question. And how can we hope, as Bacon says, to achieve the course if we have not first distinctly fixed the goal? It may be said, indeed, that there are more goals than one, inasmuch as we do not expect all our pupils to go as far as the one who goes the furthest. Be it so, but let us first settle the goal for that *one*, and then the various stages which the others may content themselves with reaching, will all lie along that more extended course.

Shall our absolutely ultimate end, then, be the production of a first-rate engineer, or of a valuable revenue officer, or of an accomplished native magistrate? With this I am not prepared to be satisfied. My proposed end is the making of each educated Hindú a Christian,—on principle and conviction This end, as I propose here to indicate implies every thing that the amplest course of education can comprise. Let us trace the assertion backward,—as thus That a Hindú should, on principle and conviction, embrace a religion which, like Christianity, bases its claims on historical evi-

dence, presupposes not merely an acquaintance with historical assertions, but a cultivation of the critical faculty, so as that the force of the historical evidence may be intelligently felt The immediate preparation for a critically intelligent study of history, is the study of Physical Geography. A history, all of whose assertions are found consistent with the multifarious information supplied by Physical Geography must be felt to present very different claims on our respect from those of a *Puràna*, with its nowhere discoverable oceans of treacle, cane-juice, and butter-milk But to apprehend with full intelligence what is presented of Physical Geography, a knowledge of Zoology, Botany, and Geology are required The full appreciation of these, again, presupposes Chemistry, in all its extensive bearings on Meteorology, climate, &c. The study of Chemistry must be preceded by that of Physics Physics demands an anterior acquaintance with the sciences of Number and Magnitude,—sciences which present the most elementary exemplification of applied Logic Such is a rapid enumeration of the great steps in the intellectual course How the moral course combines with this, we shall see, when, returning on our steps synthetically, we enquire what apparatus of educational materials the course above indicated will require.

*Science the only solid foundation of art.*

Now it may be objected as follows. "You call this an intellectual course,—it is all science,—mere knowledge,—but are we to have no applied science?—are we not to teach the *arts*?" I reply,—assuredly you have got to teach these, and if you wish to teach them effectually, you will take care that your exposition of each of them shall emanate from a previously well-digested exposition of the sciences from which the arts draw their life-blood Your instructions in Surveying will bear reference to your scientific exposition of Geometry and Arithmetic,—and will be given in the accurately determined language of those scientific expositions Your Pharmacy will be founded on your scientific exposition of Chemistry, and will avail itself of Chemical language and of Chemical principles You will not,—it is to be hoped,—when penning practical instructions for the miner, ignore the scientific views and terms of your Geology. In short, all treatises on the arts ought to bear reference to the parent sciences, and should be constructed in such exact accordance with the exposition of the parent sciences, that the artist may have nothing to unlearn, or to confuse him, when he turns to the expositions of the parent sciences for fresh suggestions in the prosecution of his art. Hence, in a systematic preparation of a literature, we must, except in cases of urgency, attend to science first: and even in the exceptional cases, you must regard your first rude manuals of art as merely provisional, and as awaiting the rectification which a thorough exposition of the parent sciences will subsequently render possible.

*The relative order of the sciences not the order in which boys are bound to study.*

A second probable objection is this, that, the course indicated above presents the sciences in an order which is not adapted to practical education. That you should begin with Logic,—then proceed to Mathematics, (including all its branches),—go next to Physics, and so proceed through the whole series of the sciences, before reading a page of History, or a chapter of Zoology, is not feasible. True,—nor do I intend that anything of the kind should be attempted. A boy may with great advantage store his mind with passages of History before he is at all qualified to decide on the historian's claims to respect; and he may, not unprofitably, become acquainted with the chemical characters of the gases, though he may not have studied Physics so as thoroughly to understand the physical principles on which the manipulation of the gases depends,—and he may profitably become familiar with the Mechanical Powers, even when his mathematical acquirements are but slender,—and he may adviseably prosecute his mathematical studies pretty far, before he turns his attention to the general laws of Reasoning,—to that abstract science, of which all other sciences are the concrete embodiments. But still the books which he reads ought all to be constructed in prospective contemplation of his eventually coming to recognise the chain of evidence in all its strength and in the logical order of its links. This cannot be expec-

ted if no attention, in the preparation of the course, be paid to the order of the links.

*Independent translational labours a source of wasteful expenditure.*

A third objection may be this, that so systematic a course, as that proposed, could not be the result of the independent working of the numerous persons who would be required to work upon it. This I most readily allow, and therefore it is, that I grieve over the comparative waste of a great quantity of independent working, which has hitherto produced loads upon loads of books, and yet, by general admission, no educational course How cooperation, as contra-distinguished from a mass of simultaneous but irrespective labour, might be secured, I must not here allow myself the space which would be necessary for discussing. Suffice it to say that my views in regard to the desirableness of a College of Translators, coincide with those set forth by Mr B. H. Hodgson in his published letters on "The pre-eminence of the vernaculars"

Let me now enumerate the sciences, and show how I think each ought to be dealt with in presenting it to India through those of the vernaculars which hang upon the Sanskrit. Let it be remembered, that I am not proposing any substitute for English education where English education is available,—and that I am not proposing that valuable English teachers who happen to have neither taste nor turn for vernacular teaching, should trouble themselves for one moment by attempting it. My suggestions have reference to that purely native agency which I contend we must employ if the millions are to be really educated In the hands of that agency I would seek to place an educational literature containing nothing that is insoluble in the absence of the power of reference to European erudition which, by the hypothesis, is not available. The native erudition, competent to the solution of all the terminology which I advocate, *is* available,—and would remain available if the English by any strange chance should have been driven from India into the sea It is scarcely worth while to remark, parenthetically, that to those who, in such event, care not what might become of India, I am not now addressing myself

*The order of the sciences.*

All science, or knowledge, rests on its appropriate evidence—direct or indirect. Sense and Consciousness are direct evidence. Inference and Testimony are indirect or mediate. In a Synopsis of the Sciences, these topics come properly at the outset; though they are not, I repeat, the topics which first demand the attention of a learner In our Sanskrit Synopsis, designed to furnish the terminology for versions in the Hindí, Bengálí, Mahratta, Telugu, &c., we treat these topics in the order of (1) the Senses and the Mind, (2) Inductive Investigation, (3) Deduction, (4) Demonstrative Exposition, i e, Rhetoric, and (5) Formal Logic The philosophical writings of the Hindús furnish a tolerably ample terminology for the satisfactory treatment of the first four of these topics; but, to be wielded with any effect at all, this terminology requires to be carefully and critically sought out, and estimated, *in situ*, not to be taken on trust from the pages of a dictionary.

*Translators—by Dictionary—of little avail, except to spoil paper.*

Moreover, where an appropriated term exists, if we fail to discover it, and if we invent a different term of our own, the established and appropriated term will be almost sure to prevent the new term from being understood, because the hearer naturally supposes that you must mean something else than what is meant by the appropriated term,—else why not have made use of that? For example,—Archbishop Whately explains *Induction* to mean the "bringing in" of instances sufficient to support a general conclusion Mr. Whewell, again, holds that the word properly means the "superinducing" of a general conception upon the observed facts Now, any attempt to translate the word according to either of these views, would only mystify a Pandit, who really has already the required idea in his mind, but a very different term,—and, in my opinion, a much better one,—to express it by. The term is *vyápti-graha*,—literally "the cognizance of pervadedness",—i. e., the cognizing that some given nature or property,—e. g., "human nature",—is invariably attended by some given nature or property,—e. g, "mortality". It may

be objected that we have nothing to do with this when dealing with the *tabula rasa* of a student's mind,—to which I reply,—that, when we have settled that a native agency must be employed in the education of the millions, and this an agency owing its value to the possession of a fountain-language,—we do ill to obtrude terms which tend to keep the learner from understanding the *right* views embodied in the time-honoured phraseology of his teacher. Why do we, in any case, obtrude our uglier term, when the finer one might be found if dug for, like a diamond, in the proper mine?

*Construction of necessarily new terms.*

But it is not so much the advisableness of learning what the Hindús *know*, before we undertake to *teach* them,—that I now seek to explain. The construction of new terms, where established terms are avowedly *not* available, is what I more particularly wish here to speak of. Formal Logic, a subject neglected or overlooked by the Hindús, demands a construction of new terms. The nomenclature of the parts of the syllogism, adopted in concert with Pandit Vitthal Sástrí, may suffice for illustration. Here equivalents were required for *proposition, term, major premiss, minor premiss, conclusion, subject, predicate, major term, minor term,* and *middle term.*

Now a proposition is "a sentence indicative," and there is no one word in Sanskrit which distinguishes a proposition from other sentences (—questions or commands—) by implying its indicative character. The matter required, therefore, to be looked at from a different point of view,—as thus. A syllogism, or argument in regular form, is called *nyáya*, and each of its three members (*avayava*) is called a *nyáyávayava*. As each of these is necessarily a proposition, it follows that the term *nyáyávayava*, though it does not etymologically signify "a sentence indicative," is yet, for the purposes of logic, its precise equipollent, and as such we employ it. Next, there is no Sanskrit word for *term*. The terms of a proposition are the Subject (*uddeśya*) and Predicate (*vidheya*), and Hindú speculators, having a separate name for each of these, did not take the trouble of devising an expression which, like our word *term*, might refer the two to one common genus. An equipollent expression being, however, wanted in our exposition,—instead of seeking to obtrude the novel and infructuous conception of the two as being alike the boundaries (*termini*) of a proposition, we accommodate ourselves to the language already in use, we dissolve the expression which will fit no Sanskrit mould, and we recast it, in a *shape which dispenses with the necessity for any accompanying explanation,*—as "that which expresses a subject or a predicate"—(*uddeśya-vidheya-bodhaka*). It may be objected that an expression like this is cumbrous, but even cumbrous instruments are not unmanageable in powerful hands,—and the Pandits of Benares are no children.

Just as we dealt with the word *term*,—making our expression denote explicitly the subject and predicate which we found already provided with separate names,—so have we dealt with the word *premiss*. There is no Sanskrit word for premiss, but there is a word for what we denominate the *major premiss*, and another for what we denominate the *minor premiss*,—(*udáharaṇa and upanaya*):—the aggregative compound of the two,—*udáharaṇopanayau*—is equipollent to "the premisses." For the other words above-mentioned there were available terms already in use.

*Mathematics.*

We pass now to those sciences in which Logic, the most abstract of the sciences, the science of the forms of Thought, first becomes concrete, by applying itself to those object-matters of the widest generality, Space, Time, and Number. For Arithmetic, Algebra, and Geometry, an exact and tolerably extensive terminology exists in the mathematical books of the Hindús. In devising additional terms,—as is necessary, for example, in the case of the Differential and Integral Calculus,—regard should be had to the analogy of the existing terms: none of which ought to be rashly set aside and replaced by new names. New names will almost certainly prove inferior to the established ones, and, further, they have a tendency to prevent the native mathematician from seeing, so clearly as he otherwise might do, that our higher mathematics are the legitimate development of his own science. The

only kind of man, therefore, to be trusted with the formation of new mathematical terms for the Hindí vernaculars, is one who unites to the most familiar conversancy with Hindú mathematics, an accurate and extensive knowledge of the modern European methods. Such a man we possess in the accomplished Bápú Deva Sástrí, to whose care and superintendence I could wish that the preparation of the whole of our Hindí vernacular course of mathematics were confided, and to whom, in the matter of mathematical terminology, I have not the presumption to fancy that I could offer any needful suggestion.

*Formal Astronomy*

The first subject,—in the order of simplicity,—to which the Mathematics are applicable, is Motion, and a science of pure Motion is found in Formal Astronomy. Here again I have nothing to suggest, but that this department also may be safely confided to the superintendence of Bápú Deva,—whose published "Euclid," "Arithmetic," "Algebra," and "Trigonometry," are models of what educational works ought to be.

*Physics.*

Force, the cause of Motion, is the next element the conception of which introduces the matter of a new science,—the so-called "Physics" The modern application of this term ought, consistently, to relegate Chemistry and Physiology to the region of Metaphysics or of Ethics But there is no use, at this moment, in quarrelling with English terms. Let us endeavour that our Indian term shall not be open to the same reproach. To ensure this, we must guard against being led away by the etymology of the name, and we must take an unbiassed view of the nature of the thing. On examining the sciences which are clubbed under the name of "Physics" we find that, while in common they treat of Force, they differ from the subsequent sciences of Chemistry and Physiology, in this, that the forces considered in the sciences called physical, produce motion or rest, but no permanent and essential change of property. The aggregate, therefore, constitutes the Science of the Causes and Conditions of Motion and Rest,—*gati-sthiti-kárana-vidyá*, or, in our local vernacular, *gati aur sthiti ke káranon kí vidyá* Under this aggregative heading we find the Mechanics of the Solid, of the Fluid, of the Aeriform, and of the Imponderable. It might seem at first sight as if our designation were inappropriate in the cases where, as in Acoustics and Optics, we take cognizance of Sounds and Colours, which are not modes of motion or rest. Strictly, the Sounds and the Colours are phenomena of *Physiology*, and not of the physical science, to whose province belong only the motions on which the physiological phenomena depend; there seems no use, however, in our attempting here to disjoin these physiological developments of the physical sciences from the physical sciences to which they are related. Our general term, then, being equivalent to "Statics and Dynamics," the four sub-divisions readily accept the names of *ghana-padártha-gati-sthiti-vidyá*, the Statics and Dynamics of Solids; *drava-padártha-gati-sthiti-vidyá*, those of Fluids, *váyava-padártha-gati-sthiti-vidya*, those of Airs; and *gurutwa-rahita-padártha-gati-sthiti-vidyá*, those of the Imponderables. To a mere English eye, these names may appear terribly long, but to a Hindú, familiar with the sense of each several member in the compound, they are not long at all. And as they carry their own meaning with them, their employment puts an end to those prevalent confusions of memory, under which a school-boy blurts out confidently, in reply to his examiner, that the radiation of Heat belongs to the science of Stereostatics, or that the pressure of liquids is a phenomenon of Optics. Where the memory loses its hold upon the sense of terms insoluble as are these Greek ones to the Hindú, it possesses no resources in itself for regaining it.

*Names may seem long, which in actual effect are not so.*

*Terms in Mechanics.*

*The Lever.*

Of the terms employed in the exposition of the Physical sciences, I shall here cite only two, in illustration of two principles. The *lever* we name *uttolana-danda*, "the lifting-rod." Now, it may seem that the word "rod" implies a solidity which does not belong to the "lever" of rational

mechanics —but the word "lever" originally meant a solid lifting-rod, and if the English mathematician, after his training in mechanics, has come to associate with the name the notion of an absolutely rigid line devoid of weight, the notion is due to that training, and not to any inherently suggestive power in the word, which it could profitably carry with it if transferred into a Hindí treatise. Whatever rationalization of the originally solid "lever" can be effected by the explanations of the science, can be effected precisely in like manner with the *uttolana-danda* of our "Synopsis."

*Impenetrability.*

The other term on which I would offer a remark is "Impenetrability" This term must have proved a source of much misery to successive generations of lecturers on Physics, for no sooner has the lecturer announced that Matter is "impenetrable" than he must breathlessly follow up the announcement with the explanatory assurance that he does not at all mean what he seems to mean, for he is perfectly willing to admit that a deal board is penetrable by a nail or by a pistol-bullet. To render the term "impenetrability" by *abhedyatá*, "incapability of being cleft,"—as I have seen it rendered,—is needlessly to multiply the terminological inconvenience just referred to What is it, then, that physicists actually *do* mean, when they speak of Matter as "impenetrable?" It is not that it cannot be pierced,—not that it cannot be divided,—not that it cannot be compressed into smaller space;—but what they mean to deny is, that Matter can be so compressed as to occupy *no* space. It may be indefinitely, but is not *infinitely*, compressible. This important philosophical conception,—much more obscured than illustrated by the term "Impenetrability,"—we convey, in our Synopsis, by the self-explanatory term *parimánátyantatyágásambhava*, "the incapability of entirely resigning bulk." It may be asked,—what Hindú will gain the conception by the mere enunciation of this term? I reply,—what human being, Hindú or European, will gain the conception by the enunciation of the word "Impenetrability?" Both terms—like other technical terms,—require explanation at the outset, and the Indian term has the merit of being to the purpose, which the English term has not. It may be worth while to notice the fact that when such a term as "Impenetrability" has been once explained by a writer, the conception is taken for granted throughout the remainder of his treatise, and the term itself scarcely ever recurs—if it recur at all. Such being the case, the apparent cumbrousness of the term by which we communicate the conception intelligibly at the outset, is of very little moment. But our term is not really cumbrous. "Civil-disabilities-removal-bill" is a term not at all cumbrous for an Englishman, though it would sorely tax the memory of the foreigner who should be required to remember it as one articulate sound simply denotative of a document upon a particular shelf.

*Chemistry.*

The next conception the introduction of which marks out the object-matter of a new science, is that of essential change of character. That the yellow substance Sulphur, and the silvery fluid Mercury, should combine to form the brilliant red Vermilion, compels us to think of some other force than that which results merely in motion or rest. This special force is termed "Chemical." Chemistry being nothing else than purified Alchemy, we reclaim to our own use the *rasáyana* of the Hindús; designing to show, under that familiar title, what the true science is. Ancillary to Chemistry is the section of Natural History called Mineralogy, *khanija-padártha-vidyá*, which we treat as an *anga*, or "appendage," of the science.

Mr. Mack, in the preface to his treatise on Chemistry, published in Bengálí and English at Serampore in 1834, tells us that he was advised to discard all European terms in his Bengálí version, but that he could not persuade himself to adopt the advice. He retained therefore many of the European names, and adapted Sanskrit terminations to them. European names I entirely discard. As an educational instrument,—and it is in *this* capacity that we at present seek to employ it,—the science of Chemistry loses more than half its value when its compound terms do not tell their own meaning; and it is impossible that they should rightly tell their own meaning to one who is not familiar with the language from which they are derived. To an Englishman, unacquainted with the classical languages, the study of a work on Chemistry

is very far from being such a mental exercise as it is to a classical scholar. The long compound names which exercise the reflection and excite the admiration or provoke the criticism of the latter, more frequently torture the memory and bewilder the understanding of the former How entirely is the scientific beauty of the nomenclature thrown away upon the man who must look out Hydrochlorate and Sesquioxide in his glossary in order to make sure which is which! It is all very well to teach long chemical names by rote to a youth who is to be employed as an apprentice in wielding a pestle. Him you perhaps do not seek to educate, you merely make a convenience of him, and if he does not practically mistake Corrosive Sublimate for Coloquintida in making up a prescription, why all is well. The case is otherwise where the aim is to educate and to instruct. Where Chemistry is to be efficiently employed for such a purpose, the learner must be conversant with Latin and Greek, or else the language of the science must be rendered into the language of the learner, as has been in a great measure done by the Germans for themselves.

*Nomenclature of the simple Bodies.*

The first question, in settling a chemical nomenclature, regards the naming of the Simple Bodies. The common metals, as well as sulphur and carbon, have names in most languages which there is no occasion for changing All the other Simple Bodies require to have names devised for them First there are the four simple gases. The name of Oxygen—'the generator of acids'—might readily be rendered by a corresponding Sanskrit compound, but this (as Mr. Mack has remarked) would only tend to preserve the exploded theory that there is no generator of acids besides Oxygen. Its old name of Vital Air connotes one of its most important characters, and therefore it has been here named *prâ̱naprada,* or *prá̱naprada-váyu,*—'the air that emphatically gives us breath.' Nitrogen (or Azote) we call *jivántaka,* 'that which would put an end to life' Hydrogen is *jalakara,* 'the water-former', and Chlorine *harita,* 'the greenish-coloured.'

Of the nine simple non-metallic bodies that are not gaseous, two, viz, Sulphur (*gandhaka*) and Carbon (*angára*), have Sanskrit names. Boron, as it is the basis of borax (*tanka*), we therefore call *tankakara*, Silicon is the generator of flint,—*agni-prasthara-kara;* Selenium,—so named after the moon,—we have likewise named after the moon,—*chándra,*—it being at present a matter of moonshine what so rare and unimportant a substance be denominated Phosphorus is *prakás'ada* 'the giver of light,' Bromine is *púta* 'the fetid;' Iodine is *aru̱na,*—the name, like the Greek one, referring to the violet colour of its vapour, and Fluorine is *káchaghna kara* 'the generator of that (fluoric acid) which corrodes glass'

Of those metals which have no names in Sanskrit, Platinum, the 'heaviest' of metals, is, with allusion to its weightiness, named *gurutama*; and Potassium, the 'lightest,' *laghutama*. Sodium is 'the basis of culinary salt'—*lava̱na-kara.* Zinc, the Urdú name of which is *dastá,* we have named *dasta*—with allusion to the way in which its oxide, the 'philosophical wool,' is 'tossed about' in the air.

*Of Binary compounds.*

Taking such, then, as the names that we have to deal with in forming the names of Compounds,—we come first to binary compounds Compounds must have names suggestive of the fact that they are *acid* or otherwise. The termination *ic* belongs to the Sanskrit as well as to the Latin,—so that Sulphur and Sulphuric Acid can be satisfactorily rendered *gandhaka* and *gándhakikámla.* To the acids in *ous* another termination (*ya*) has been appropriated. To the non-acid binary compounds, without attempting at present to fix separate terminations for the several varieties, the general termination *ja*—meaning 'produced from'—has been assigned. Thus an Oxide is *prá̱naprada-ja*; a Chloride *harita-ja*, and so on. The Alkalis—potassa and soda—take feminine names, according to the analogy of the Latin, from those of their metallic bases,—thus—*laghutamá* and *lava̱na-kará.*

*Compounds of compounds.*

Coming to the compounds of compounds,—as the acid affix *ic* changes to *ate* in the name of the resulting salt, the Sanskrit *ika* is replaced by *áyita* Thus, as the Sulphuric Acid gives a Sulphate, the *gándhakikámla* gives a *gandhakáyita.*

It should be unnecessary to remark, that the suitableness of these names is not to be estimated on the principle which led the British sailor to set down the Spaniards as a nation of fools because they call a hat a *sombrero*. To the British sailor the word 'hat' sounds much more natural than sombrero, and for like reasons 'Sulphate of Soda' may seem to sound much more natural than *lavaṇa-karáyá gandhakáyitam* But as 'hat' is not good Spanish, so 'Sulphate of Soda' is not good Sanskrit, and this leads us to forestall another criticism of kindred calibre. Is the sombrero-like expression, *lavaṇa-karáyá-gandhakáyitam,* good Sanskrit? The question is not to be resolved by submitting the term to a Sanskrit grammarian ignorant of modern science,—to whom, without an attentive, serious, ingenuous, and uncavilling study of the tract in which it appears, the term has a *right* to be as obscure as the term Binoxalate of Potassa to the grandfathers of Lindley Murray.

*Objections to the translation of scientific terminology dissected.*

Having shown that the nomenclature of Chemistry can be reproduced in an Indian language, and finding that my Pandits now take a lively interest in the science, which formerly they regarded with indifference,—looking, as they did, upon our *áksijen* and *haidrajen* as things of no more concern to Indian life than tomahawks and wampum are to ours,—I think it worth while to dissect the following remarks which appear in a recent fasciculus of Selections from the Records of Government N. W P. The remarks are these.

*Futile objections stated.*

"I cannot imagine any one proposing to translate all the no- "menclature and terminology of the arts and sciences; even "were it easy of performance, it would in many cases be useless in Chemistry, for in- "stance, it would establish the misnomer Oxygen (I may add Hydrogen) and the "indefinite names, Chlorine, Bromine, Ammonia, &c. Were Hydriodate of Potash "translated into Arabic or Sanskrit, a Maulavee or Pundit would perceive that the "name was composed of words meaning water, purple, a saucepan, and ashes, but "he would never be able to select that substance from several placed before him, for "it is a dry white cubical crystallized solid"

Now it has been already seen that I expressly *reject* the sense suggested by the term "Oxygen," and ground my denomination of the element on that characteristic feature,—its being the "Vital Air,"—which no revolution in Chemical theory is likely to deprive it of. So much for the reverence shown in the Benares College for the supposed obligation to perpetuate misnomers in translation.

*The logical "Fallacy of Objections" exemplified in the passage under review.*

Now look at the rest of the passage. The writer says we should also have to perpetuate "indefinite names" such as Chlorine. But do we escape the indefiniteness by adopting the indefinite name itself, and writing it *Klárin gess*? If the indefiniteness is productive of no evil in Europe, where the name reminds us at least of the characteristic "greenness" of the gas, why should a like indefiniteness in the Indian term be dreaded *here*? To reject a self-explanatory name, (our *harita váyu,*—green air,) which is precisely as definite or as indefinite as the European one, in favour of a name which here suggests nothing at all, seems strange The besetting delusion in the passage under review is what may be found admirably described in Whately's Logic (p. 98 of our Reprint No. 6) under the denomination of the "Fallacy of Objections." Suppose two ferry-boats. The traveller objects to one of them that it is cumbrous; and having thus condemned it on the strength of the objection, he steps unhesitatingly (—as the necessary alternative—) into the other, which, rotten and leaky, will sink under him before he has got a third of the way across.

*Further, and perhaps supererogatory, exposure of the Fallacy.*

At the risk of being tedious—since the case of the Oxygen suffices to dispose of the principle in question,—I cannot refrain from remarking on the treatment of *Hydriodate of Potash* in the passage under review. The writer alleges that the term Hydriodate of Potash, if translated, into Arabic or Sanskrit, would be seen by a Maulaví or a Pandit, "to be composed of words mean-

"ing water, purple, a saucepan, and ashes; but he would never be able to select "that substance from among several placed before him, for it is a dry, white, cubical. "crystallized solid." The reasoning here is unsatisfactory. The sense of the Sanskrit translation would never enable the Pandit to recognize "a dry white cubical crystallized solid,"—but does the writer conceive that in the term Hydriodate of Potash, formed of Greek and English, the sense of the same linguistic elements is of itself qualified to suggest "a dry white cubical crystallized solid"? He will reply, that the name will suggest the thing, when the thing has been shown, and the applicability of the name has been explained:—but precisely so will it be in the case of the properly constructed Sanskrit term; so where is the relevancy of the objection? To have the shadow of a leg to stand upon, it must borrow the principle of the British sailor already cited, who held that the word "hat" was *naturally* significant, and that the Spaniards were fools for calling it a *Sombrero* "Why cant they call it a *hat*, when they must know it *is* one"?—and, analogously—"why cant they call it Hydriodate of Potash, when they must know it *is* Hydriodate of Potash"?

*Practical refutation of the objection in question.*

Let me show how little, in the Benares College, we find ourselves encumbered with the fanciedly inevitable "saucepan" and "ashes", when reproducing the term Hydriodate of Potash in a form suited to furnish matter for the *judgment* and not merely for the *memory*;—in a form, that is to say, educationally valuable and not educationally valueless. Knowing that the more strict designation is *Iodide of Potassium* (—just as Chloride of Sodium is scientifically preferable to Muriate of Soda—), we look, in our list of elements, for *Potassium*,—and we find it designated not with reference to the "ashes" of the "saucepan," but with reference to its being the "*lightest*" metal (*laghutama*). Iodine, again, (*aruṇa*) is named after the colour of its vapour, just as in the European nomenclature Our term, therefore, is *laghutamasyáruṇajam*,—or, vernacularized, *laghutam ká aruṇaj*,—"the iodine-product of potassium." Now, to one who has been instructed regarding the elements, and the principles of nomenclature in designating compounds, this is *self-explanatory*. If any doubt or dispute arise regarding its sense, a reference to the account of the Elements determines the question, and, again, the etymological sense of the names assigned to the Elements can, in case of doubt, be ascertained by consulting a Pandit. There is no occasion for a reference to an *educated Englishman*. By such and similar means, and by such only, shall we ever succeed in *naturalizing* our knowledge among the Hindús. The lazy barbarous plan of talking (—to those who are not intended to learn English—) about *klárin gess*, and *haidraiyadet áf patáss*, is, frankly, a wretched accomodation to the mental indolence of English teachers and of incompetent translators.

Many of the names which I have proposed must necessarily, as I have already said, appear very long ones to the mere English reader, to whom the elements of the names convey no sense, just as "tithes-commutation-amendment-bill" must appear a very long name to a person ignorant of English. But if it would be cruelly unprofitable to attempt to impose on the mere English reader the employment of a terminology, to him key-less and non-significant, so cumbrous as our Sanskrit terminology would necessarily prove to him, is it less cruelly unprofitable to attempt to impose on the teachers and pupils of the purely native schools, the employment of a terminology to *them* key-less and non-significant, and just as cumbrous? It is not for *English* teachers that the vernacular terminology is required, but for the hundreds of *native* teachers whom I hope to see trained; and for the trainers of those teachers in the normal classes which I hope to see ere long rapidly filling up.

*Greek words in the Arabic the reverse of beneficial to the latter.*

We have seen it urged that the *Arabic* has not disdained to borrow from the Greek. True,—and its borrowings are blots upon the language. What, for example, is gained by styling an Introduction to Logic *ísá ghojí*,—because, forsooth, the Greek term is *eisagogé*? Nothing but mystification and pedantry is advanced by the sanctioning of cabalistical gibberish like this.

Had the Arabs kept up a knowledge of the Greek language, as has been done in Europe, *then* the case would have stood very differently.

*Worthlessness of Greek contributions to Arabic illustrated.*

To make this point clear, I shall avail myself of some observations on language by the Rev. Chenevix Trench Quoting "a great writer not very long departed from us", Mr Trench (at p 4 of his delightful little volume "On the Study of Words") says—" there are few modes of instruction more "useful or more amusing than that of accustoming young people to seek for the ety-"mology or primary meaning of the words they use. There are cases in which more "knowledge of more value may be conveyed by the history of a word than by the "history of a campaign". Let us test this principle by the case of a Greek word borrowed by the English and by the Arabic :—let us take the word *philosophos*. The English teacher, learned in Greek, or having access to the learning of those who are, can explain to his pupil how the " philosopher" was he who modestly disclaimed the proud title of *sophos* or " wise," and professed himself merely a " *lover* of wisdom." How much of this teaching can the modern Maulaví extract from the exanimate sound *failsúf*? Ignorant of Greek, and without access to those to know it, the Arabs can boast of a very poor linguistic acquisition indeed when they point to the defunct *failsúf* of their lexicon.

*The worse than uselessness of Greek contributions to Arabic illustrated.*

Further,—Mr. Trench (at p. 182 of his "English—Past "and Present,") says,—One of the most frequent causes of "alteration in the spelling of a word is a wrongly assumed "derivation. It is then sought to bring the word into har-"mony with, and to make it by its spelling suggest, this de-"rivation, which has been erroneously thrust upon it " He continues (at p 188)—" It is foreign words, or words adopted from foreign lan-"guages, as might beforehand be expected, which are especially subjected to such "transformations as these. The soul which the word once had in its own language "having departed from it, for as many as do not know that language,—or not being "now any more to be recognised by those who employ the word, these are not satis-"fied till they have put another soul into it, and thus it becomes alive to them again. "Thus——to take first one or two familiar instances, but which serve as well as any "other to illustrate my position—the Bellerophon becomes for our sailors the 'Billy "Ruffian,' for what can they know of the Greek mythology, or of the slayer of the "chimæra?" Now, may we not discern something of this process in the *ísá ghojí* above referred to? The word, when the Arabs left off studying Greek, become examinate , and may we not trace a " Billy-Ruffian"-like attempt to reanimate it by splitting the *eisagogé* in two, and spelling the first half like a proper name? The word *ísá* means " Jesus." " Jesus ghojí" might perhaps (to the Arab analogues of the sailors of the " Billy Ruffian") adumbrate some supposed author or patron of the work.

*The argument founded on the superficial and fancied analogy, when looked at more deeply and seriously, proves the very reverse.*

If such and such-like are the gains which Arabic has made by borrowing from the Greek, does the example hold out encouragement to the plan of deluging the Indian vernaculars with our Greek scientific terminology; or does it not rather hold out a caution and a warning? We may smile at the successful resurrection of " Bellerophon" in the shape of " Billy Ruffian," and shrug our shoulders at the barely half reanimation of the Greek *eisagoge'* as *ísá ghojí*,—where the *ghojí* means nothing and so remains dead; but what ingenuity of Hindú thought is to reanimate the *haidraiyadet áf patáss*, after it shall have been reposited as a mummy in the catacombs of the sham-vernacular?

*The hinge of the cosmopolitan analogy.*

That a Graeco-latin terminology of science is cosmopolitan throughout Europe, is the natural and appropriate consequence of the fact that every nation in Europe has *retained its hold* upon the Greek and upon the Latin. This is the

one sole cardinal element in the analogy,—the hinge on which it hinges if it is to hinge at all This, the one solely and cardinally important element in the analogy, is non-existent in the case of the Indian vernaculars, just as I have shown it to be absent in the case of the Arabic. To the logical reader what need I say more ?

*Rootless branches do not flourish.*

The difference between a scientific terminology with the means of access to its radicles,—and the same dissevered from such means of access, suggests the illustration of the Electro-magnet in its two widely different conditions A mass of soft iron acts as a magnet,—a most potent magnet,—so long, but only so long, as it remains in connection with the Galvanic Battery. Break the connection, and your magnet lapses into an inert mass of soft iron The offhand plan of transplanting into the vernacular a terminology dissevered from its roots is but an imitation of the child who with impatient eagerness extemporises a garden by sticking in the ground flowers plucked from his father's bushes. Such floriculture may look imposing at the moment, but only to children

*A futile challenge anticipated.*

Some advocate of the easily constructed and useless sham-vernacular—where "transliteration" claims the honours of "translation,"—will probably exclaim, in indignation at my uncompromising exposure of its rootlessness—"Well then, "—you, who pretend that everything both can, and ought to, be honestly translated, "as you call it,—tell me—right off—on the moment—and without a moment's pause "or reflection,—how will you translate this, and this, and this, and that,—and ten "hundred thousand other things ?" I reply, that my recorded and standing protest against the indolent impatience which I so much deprecate, suggests, of itself, the reason for my answering no one of these questions until I shall have given it such patient, careful, and studious consideration as may perhaps enable me to answer it worthily.

*Imagination no legitimate substitute for candid examination.*

We have seen that the writer on whom I have been animadverting says "I cannot imagine any one proposing to "translate all the nomenclature and terminology of the arts "and sciences." But why, in this way, trust everything to *imagination ?* If the man who proposes to undertake the task, brings forward a fair sample of that task already executed, then a candid examination of the work done might peradventure help the lagging "imagination." If, on the other hand, it can be shown that the work is not worthily executed,—*that* may furnish reason for frowning on the undertaking,—but not so the objector's lack of imagination. This is just another and a very noticeable phasis of that indolent impatience which Lord Bacon has limned with such keen master-strokes at the opening of the 88th aphorism of the Novum Organum "At longe majora a pusillani-"mitate, et pensorum, quae humana industria sibi proposuit, parvitate et tenuitate, "detrimenta in scientias invecta sunt. Et tamen (quod pessimum est) pusillanimi-"tas ista non sine arrogantia et fastidio se offert." Which we may English thus .—"But far greater detriments have been brought upon the sciences through pusillani-"mity, and the littleness and slenderness of the tasks which human industry has "proposed to itself. And yet (—what is the worst of it—) this same [*ista*] pusil-"lanimity presents itself not without arrogance and disdain."

*Difficulty no reason for shirking a sacred duty.*

Our objector urges as an objection to undertaking the task of translating the language of European science into the Indian dialects that it is not an "*easy*" one But it is not in the hope of finding it an *easy* task, that any man, competent to judge of the case at all, is likely to devote himself to the solution of such a problem,—or to meddle with the solution at all From this long controversial digression, let us revert to the handmaid of Chemistry, viz., Mineralogy.

*Mineralogy.*

For the exposition of Mineralogy, we find a good number of terms ready to our hand, but there are many more which we must ourselves devise. Where two different mine-

rals, e. g., Talc and Mica, are confounded under one name, *abhraka*, we distinguish them by specifying their most characteristic or most obvious difference. Seeing that Mica is elastic, and Talc not,—we designate them as *sthitisthápaka-vis'ishta* and *sthitisthápaka-rahita* severally. Where the European name alludes to the structure,—as in the case of Granite,—we preserve the allusion, as in our term *kanochchaya-prastara* "the rock which is an agglomeration of grains." Of course the explanatory "*prastara*" can be dropped when the pupil is familiar with the term,—just as the word "rock" in "trap-rock," is habitually dropped in English. Names that convey no sense,—names simply denotative,—as "Basalt" we render by some obvious character of the thing denoted. "*Basalt*" we render *krishna-prastara* "black rock." It may be objected that many rocks (—Obsidian in particular—) are black, no less than Basalt is. I reply, that European mineralogists and geologists name a certain rock Greenstone," (—*harita-prastara,*) without regard to the fact that many other stones are green. Greenstone is the most important of the rocks that are green, and Basalt of those that are black. We cannot reasonably here be required to attain a precision of nomenclature which has not been attained in Europe, and which, on principles of philosophical necessity, is not attainable at all. In conclusion, as regards naming the Minerals,—where there is no native name, and nothing suggestive in the European name, and no very marked characteristic property,—as is the case with "Gypsum," —we may designate the mineral by reference to its chemical composition. Thus "Gypsum" is *chúrna-gandhakáyitátmaka-prastara,* "the rock which consists of Sulphate of Lime."

*Vegetable Physiology, and Botany.*

The additional conception of *Life* gives occasion for the next in the order of the sciences,—viz., Vegetable Physiology,—with its ancillary section of Natural History, named Botany. Here we find some terms ready to our hand. For example, cryptogamic plants are classed under the head of *vanaspati,* while the phanerogamic are termed *vánaspati.* The Hindús, however, have fallen into such errors as that of ranging the *fig* among the cryptogamic. The "stamens" and "pistils,"—not discriminated from each other apparently by Hindu physiologists,—we distinguish into *paurusha-kesara,* "the male filaments," and *straina-kesara,* "the female filaments."

*Animal Physiology and Zoology.*

The next of the sciences is marked off by the introduction of the additional conception of *Sensation.* Here we have Animal Physiology,—with its ancillary section of Natural History, termed Zoology. For the more obvious parts of the body we find names ready to our hand. For the more minute parts, names will have to be adapted. Where the Hindús, for example, have not discriminated the nerves from the veins, we must designate the former by some such term as *mastishka-tantu,* "thread of cerebral matter." "Chyme" and Chyle" are not discriminated by the Hindús. They can be easily distinguished in our terminology by prefixing to the established name for both,—viz., *dhátupa,*—the specification of its being "the prior," or "the latter,"—*púrva or uttara.*

*Zoological divisions.*

In dividing the Animal Kingdom into its four provinces, we call the "Vertebrata" *prishthavansa-vis'ishta,* those "distinguished by a backbone",—the "Mollusca" *komalas'aríra-visishta,* "distinguished by a soft body, the "Articulata" *kánda-vis'ishta,* "distinguished by their sections," and the Radiata" *samánávayavávritta-nábhi-vis'ishta,* "distinguished by a centre with similar members disposed around it."

*Geology.*

All those sciences which we have thus hastily run through, are put in requisition by *Geology.* As for the terms to be employed in the exposition of Geology, the Mineralogical ones have been already discussed. Of things Organic, belonging specially to Geology, I shall cite only two examples,—each to illustrate a principle. The "Mammoth' —whose name is to us simply denotative, or non-significant,—I speak of as the *práchínakálika hastin,* "the elephant of the old world." The "Ichthyosaurus," on the

other hand, whose name is connotative, I render in accordance with the connotation, and denominate the *matsya-makara*,—the "fish-lizard."

*Physical Geography.*

Furnished with the knowledge supplied by the sciences which we have reviewed, the enquirer will next ask—what, in consequence of all these entities and agencies, is the actual aspect of the globe on which we dwell? He desires instruction in Physical Geography. When we have once thoroughly secured right terms in all the sciences which we have been considering, the question of terminology for the exposition of Physical Geography presents few difficulties. While we endeavour to give an accurate general conception of the contour of the land and water of the globe, we must take care to proportion the minuteness of detail to the historical importance of the several regions. We must not waste upon Tierra del Fuego or Nootka Sound the fulness of detail which may be due to the plateau of Central Asia, or the valleys of the Euphrates and the Nile. Physical Geography is the legitimate introduction to Civil History, and our teaching of it ought to be regulated by the consideration of what we intend to teach of Civil History.

*Civil History.*

Since, in the department of Civil History, I have nothing which I wish at this moment to suggest in the matter of terminology, I shall here content myself with remarking that our first exposition ought to be rigidly bare of ornament and flourish. The historical series should be so constructed that no allusion shall anywhere occur which the perusal of what went before does not qualify the attentive reader to understand. This obvious precaution has hitherto been much neglected.

*Political Economy.*

From History we advance to one of the considerations which the perusal of History should naturally suggest to the thoughtful reader. Certain courses of conduct appear to have enriched a nation,—other courses to have kept a nation poor, or to have reduced it to poverty. What are those courses severally? Adam Smith's reply to the question was given under a title which I should have no objection to adopt,—giving the science the name of *des'a-dhana-vriddhihrása-kárana-vidyá*,—i. e, "the Science of the causes of the increase and the decrease of the Wealth of Nations". Whether a name moulded on this view of the question be adopted, or a name moulded on Whately's stricter view of the science as "The Theory of Exchanges"—*ádana-pratidána-vidyá*,—let us at all events sink the hideous *pálitikal ikánami*, with which the hybrid treatises have hitherto puzzled India.

*Ethics.*

Following the thread of connection among the sciences, we find that a fresh consideration inevitably meets us. The wealth of a nation, as of an individual, may be increased by practices against which Political Economy offers no remonstrance, but yet against which there is *something* in the human soul that revolts.

For example, the wonderful and beneficial results of the Division of Labour are among the most attractive of the subjects offered to our contemplation at our entrance upon the study of Political Economy;—but when we find this division and subdivision carried out to such an extent that a human being becomes a mere machine for the sole and life-long performance of some such labour as the pointing of a pin, a mournful feeling comes over us; and we cannot help asking "*ought* this to be exactly as it is"? The word "ought" embodies a new conception,—the essential conception on which is based the science of Ethics.

*Natural Theology.*

Still another consideration arises out of the moral one last adverted to. *Why* do we feel this obligation in regard to right and wrong? Be the answer what it may, all experience shows that the human mind turns instinctively towards a Ruler, to whom we feel ourselves under the obligation that we do always what is right and abstain from what is wrong. Again the consideration of the external world points to the fact of there being One Almighty Governor. But the question is not to be taken for granted. The decision, to a thoughtful mind, would be much more satisfactory if supported by

evidence. The evidence lies abundantly around us,—the evidence of the being of a God,—the evidence of *Natural Theology*

*Revelation.*

Natural Theology closes the series of our secular teaching. The conclusion reached by Natural Theology compels the thinking mind to ask the question, "Has the God of Nature anywhere revealed Himself to man?" The answer to this question we offer to the Hindú in our Scriptures. But his compatriots, he replies, have scriptures of their own. True, we rejoin,—but scriptures resting their claims only on the futile ground of self-assertion. Of our own, we tender him the Evidences, Historical, and Internal; and here our prefatory remarks must close.

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# A SYNOPSIS OF SCIENCE.

## INTRODUCTION.

(1). Glory be to the Lord the Most High, who creates, by His will merely, the world, filled with innumerable things, having countless qualities hard to be ascertained. Through His favour alone, having long pondered the import of the Aphorisms, (*sútra*), of Gautama, I compose a treatise on a new plan, for the general benefit. The subject here investigated is, the extent to which the sentiments of the modern English coincide with, or differ from, those of Gautama. May this work of mine, the result of not a little labour, treating of many matters in few words and yet plainly, prove acceptable to the intelligent.

(2). It is agreed alike by the learned of India and by the learned of other countries that the Chief End of Man, (*parama purushártha*), is not to be attained without a knowledge of the truth in regard to our souls and other things which it is desirable should be rightly known. Therefore those who desire to attain the Chief End of Man ought certainly to strive to obtain a knowledge of the truth in regard to the soul, and in regard to things other than the soul. Further, since some knowledge of the truth in regard to such matters has been attained, we ought to endeavour to communicate it. Therefore, commencing the discussion of those things, we enounce the object-matters, (*vishaya*), of discussion as follows.

# BOOK I.

### Section I.—The Purpose of the Proposed Enquiry.

*Aphorism I.*

We investigate the truth regarding (1) our instruments [in the acquisition] of knowledge, (*pramáṇa*), (2) the objects, (*prameya*), [to which these are applicable], (3) [the state antecedent to knowledge, viz.,] doubt, (*sanśaya*), (4) the motives, (*prayojana*), [for passing from the state of doubt to that of knowledge], (5) data [to start with, whether] popular, (*dṛishṭánta*), or (6) scientific, (*siddhánta*), (7) the procedure, (*avayava*), [in explicating from data what is implied in them], (8) [the method of] confuting, (*tarka*), [unwarranted objection, so as to arrive at] (9) certainty, (*nirṇaya*), (10) [the nature of fair] debate, (*váda*), (11) wrangling, (*jalpa*), (12) cavilling, (*vitaṇḍá*),

(13) fallacies, (*hetwábhása*), (14) [disingenuous] artifices, (*chhala*), (15) futile oppositions, (*játi*), and (16) occasion for rebuke, (*nigrahasthána*), —since this is conducive to [the attainment of] the Chief End of Man.

(1). 'Since *this*';—i e., since a knowledge of the truth.

(2). And since the attainment of every result is dependent on *instruments*, (*karana*,) instruments are necessary in the attainment of a knowledge of truth also;—so the 'instruments for acquiring knowledge,' (*pramána*), are here set forth first [in the list].

(3). Now there is an aphorism to set forth the order in which the knowledge of truth is conducive to [the attainment of] the Chief End of Man.

*Aphorism II.*

Pain, (*duhkha*), Evil Action, (*kupravritti*), Improper Emotions, &c., (*anuchita-rágádi*), and False Notions, (*mithyájnána*),—without the successive removal of these [—beginning with the last—], there is not the removal of the successively preceding ones which arise from these; and not without this [successive removal of the whole], is there the Chief End of Man.

(1). Gautama's second aphorism is, as follows;—"Pain, (*duhkha*,) Mortal Life, (*janma*), Activity, (*pravritti*), Fault, (*dosha*), False Notion, (*mithyájnána*), —since on the successive departure of these in turn, there is the departure of the one next before, there is—from the departure of the last of them —Beatitude," (*apavarga*.) Gautama's doctrine here is, that, on the departure of False Notion, the three Faults, (*dosha*,) [—as he designates them—] of Desire, (*rága*), Aversion, (*dwesha*), and Delusion, (*moha*), depart. Hence Action, (*pravritti*), ceases to take place. Consequently Birth, (*janma*), does not recur. And thus there is no Pain,—and the absolute cessation of Pain is the Chief End of Man. But *our* opinion is, that improper Desire, &c, is not the result solely of False Notion, for, even where there exists true knowledge, e. g., in regard to morality, (*dharma*),—as thus "This property of another's ought not to be taken by me, and in taking it I shall be blameable,"—men still desire to appropriate what belongs to others. Hence it is not a matter of course that Improper Desire should depart on the departure of False Notion; but whatever Improper Desire is the result of False Notion, will not depart *without* the departure of the False Notion; and without that there is not the Chief End of Man.

(2). Here ends the section on the purpose of the proposed enquiry.

(3). Now since a definition, (*lakshana*), will be looked for, [of each of the things enunciated in the 1st Aphorism,] in the order of enunciation, we define and divide that first enounced, viz., Instrument of knowledge, (*pramána*).

## Section II.—The Instruments available in prosecuting the enquiry.

*Aphorism III*

By Instruments of knowledge we mean instruments of correct knowledge; and these are of two kinds, (1) the Senses, (*pratyaksha*), and (2) the Knowledge of Signs, (*anumána*).

(1). Gautama's third aphorism is as follows;—"The Senses, (*pratyaksha*), the Knowledge of Signs, (*anumána*), Knowledge of a Likeness, (*upamána*), and Testimony, (*śabda*), are the Instruments of knowledge." Here Gautama holds that the Knowledge of a Likeness, and Testimony, also are instruments

of knowledge independently, like [or coordinate with] Sense and the Knowledge of a Sign. But *our* opinion is, that, nothing else than an *inference*, (*anumiti*), as to the relation between a thing named and the name, is produced by what is [by Gautama] imagined [to be a third coordinate variety of evidence] under the name of "Knowledge of a Likeness";—e. g., the knowledge of the likeness of a Bos Gavaeus to a cow, ensuent on the understanding of the meaning of the assertion that "What is meant by the term Bos Gavaeus is a thing like a cow,"—and Testimony, in the shape, e. g., of the assertion that "Devadatta is going to the village," simply causes us to *infer* [—not otherwise than in ordinary cases of inference—] the speaker's opinion with reference to the going towards the village by Devadatta:—so that these two are not independent instruments of knowledge;—hence we said [in our aphorism] "and these are of *two* kinds"

(2). Now we proceed to characterise these two instruments of knowledge in their order; and first we characterise the Senses, (*pratyaksha*).

*Aphorism IV.*

By a Sense is meant a power, (*śakti*), resident in this or that part of the body, (*śaríra*), in virtue of which, on there being a suitable collocation of the bodily part and its appropriate object, (*artha*), direct knowledge of the object takes place.

(1) The definition of Sense, according to Gautama's doctrine, is this, that, "Sense, (*pratyaksha*), is the instrument of the knowledge which arises on the conjunction of a Sense, (*indriya*), with its object," but this we reject, because of its involving a vicious circle; that is to say, because, inasmuch as the word *pratyaksha* and the word *indriya* are [in Gautama's aphorism] synonymous, this is as inadmissible as the defining a hatchet by saying "A hatchet is the instrument in the cutting which results from a hatchet." So, although the word *pratyaksha* has the three meanings of (1) the object [of sense], (*vishaya*), (2) the knowledge, (*jnána*), and (3) the organ which is the instrument of the knowledge, (*jnána-karaṇam-indriya*),—yet here the word *pratyaksha* is employed solely as meaning the Senses, (*indriya*),—the special powers, (*śakti viśesha*),—since thus no room is left for mistake or doubt founded on the intrusion of other meanings.

(2). Next we characterise, and divide, the Knowledge of a Sign, (*anumána*).

*Aphorism V.*

Now, preceded thereby, the Knowledge of a Sign is of three kinds, (1) that which involves the prior, (*púrvavat*), (2) that which involves the posterior, (*śeshavat*), and (3) the perception of homogeneousness, (*sámányato-drishṭa*).

(1). 'Preceded thereby,' i. e., preceded by sense. The meaning is, that, the Knowledge of a Sign is of three kinds,—its threefold character being stated as follows, 'that which involves the prior,' &c. That [Knowledge of a Sign] is said to involve 'the prior,' where an effect, (*kárya*), is inferred from a cause, (*káraṇa*); as when, from the rising of clouds it is inferred that there will be rain. Again, where from an effect the cause is inferred, that is said to 'involve the posterior;' as when, on seeing the water of a river changed in colour from what it was before, and the fulness and rapidity of the current, it is inferred that there has been rain. Where,

from seeing somewhere a blossoming mango-tree, it is inferred that the mango-trees in other places also are blossoming, that [Knowledge of a Sign] consists in the perception of homogeneousness."

(2). Now, although Testimony, (*śabda*), and the Knowledge of a Likeness, (*upamána*), are not independently causes of right knowledge [Aph. III, § 1], yet as we allow that, as forms of *inference*, they can communicate right knowledge, and, since we accept Gautama's definition and division of them, intending, for the information of the learner, to set forth the Knowledge of a Likeness, and Testimony, we define first the Knowledge of a Likeness.

*Aphorism VI.*

The Knowledge of a Likeness is the instrument-in-the-ascertaining, (*sádhana*), of that-which-was-to-be-ascertained, (*sádhya*), through a likeness to something well-known.

(1). That is to say,—a Knowledge of a Likeness is that whereby there is 'ascertainment,' or establishment, (*siddhi*), of that which was to be established, 'through a Likeness,'—i. e., through the knowledge of a similarity, to 'something well-known,' i. e., to something known before; —as in the case of "This is like a cow"—[Aph. III, § 1].

(2). We define Testimony.

*Aphorism VII.*

Testimony, (*śabda*) [—such as constitutes *real* evidence—] is the declaration, (*upadeśa*), of one worthy [to be believed], (*ápta*).

(1). This is plain. We divide it.

*Aphorism VIII.*

It is of two kinds, in respect that it may be 'that whereof the matter is seen,' (*drishṭártha*), or 'that whereof the matter is unseen,' (*adṛishṭártha*).

(1). That is to say,—'it,' i. e., Testimony, is of two sorts. That whereof the matter is here [on earth] visible, is 'that whereof the matter is seen;' as, e. g., when the Ganges is spoken of. And that of which the matter is visible in another world, is 'that whereof the matter is unseen;' as, e. g., when Paradise is spoken of.

(2). Here ends the section on the instruments of knowledge.

SECTION III.—THE OBJECTS ABOUT WHICH THE ENQUIRY IS CONCERNED.

(3). Now, since it will be enquired, what is to be known by means of these two kinds of Instruments of knowledge, commencing a section on the objects of right knowledge, (*prameya*), we give the division of these.

*Aphorism IX.*

Soul, (*átmá*), body, (*śaríra*), sense, (*indriya*), sense-object, (*artha*), understanding, (*buddhi*), the mind, (*manas*), evil deeds, (*kupravṛitti*), evil passions, (*anuchita-rága*), mundane life, (*sáṅsárika-jívana*), retribution, (*phala*), pain, (*duḥkha*), and the Chief End of Man, (*parama-purushártha*),—such are twelve objects concerning which it is desirable that we should have right notions.

(1). This is plain. Among these we define Soul, the one first enounced.

*Aphorism X.*

Desire, (*ichchhá*), aversion, (*dwesha*), volition. (*prayatna*), pleasure, (*sukha*), pain, (*duhkha*), and knowledge, (*jnána*), are the sign, (*linga*), of the Soul, (*átmá*).

(1). 'Sign,' i. e., that whereby [any thing, of which it is characteristic,] is recognised.

(2). We define Body, which presents itself next in order.

*Aphorism XI.*

The Body, (*śaríra*), is the site, (*áśraya*), of gesture, (*cheshtá*), of the senses, (*indriya*), and of the feelings, (*artha*).

(1). 'Gesture' is that species of action which originates in volition [or voluntary effort]; the 'Senses' are the Sight, (*chakshus*), &c.; the 'Feelings' are pleasure and pain. The meaning is this, that the body is the site of [all] these:—here each severally, viz., the being the site of gesture, &c., is a characteristic [—i. e., something sufficient to ascertain—body].

(2). We divide and define 'Sense,' which comes next in order.

*Aphorism XII.*

The Senses, the Smell, (*ghrána*), Taste, (*rasana*), Sight, (*chakshus*), Touch, (*twach*), and Hearing, (*śrotra*), are what apprehend the qualities, (*guna*), of the Elements, (*bhúta*), and of the things formed of these.

(1). Of these, the Smell is the apprehender of Odour, (*gandha*), the Taste of Savour, (*rasa*), the Sight of Colour, (*rúpa*), the Touch of Tangibility, (*sparśa*), the Hearing of Sound, (*sabda*); therefore the Senses are defined as the apprehenders, (*gráhaka*), of the several qualities:—such is the import

(2). With reference to the question, which are the Elements?—we remark.

*Aphorism XIII.*

The Elements are about sixty in number.

(1). Gautama's aphorism, in this place, is, that, "Earth, (*prithiví*), Water, (*ápas*), Fire, (*tejas*), Air, (*váyu*), and Ether, (*ákáśa*), are the Elements,"—but *we* do not admit the elementary character of these, Earth, &c.; because elementariness means the being an uncompounded, (*amiśrita*), substance,—that is, the being a substance *not* resulting from the conjunction of several mutually heterogeneous parts; and this is not the case with Earth, Water, Air, &c., for it has been established by various cogent experimental proofs that of [each and all of] these the constituent portions *are* mutually heterogeneous. But of those which will be mentioned, viz., Oxygen, (*pránaprada*), &c., the elementary character is probable, because hitherto it has not been established by any experiment that their constituent parts are mutually heterogeneous. But the explanation of this matter is to be looked for in the section on Chemistry, (*rasáyana*).

(2). We divide and define Object [of Sense], which next presents itself.

*Aphorism XIV.*

Their Objects, (*artha*), are the qualities, (*guṇa*), of the Elements, (*bhúta*), and of things formed of these,—viz., Odour, (*gandha*), Savour, (*rasa*), Colour, (*rúpa*), Tangibility, (*sparśa*), and Sound, (*śabda*).

(1). 'Their Objects', i. e., the Objects of those—the Senses;—meaning their [appropriate] provinces, (*vishaya*).

(2). We define Understanding.

*Aphorism XV.*

Understanding, (*buddhi*), Apprehension, (*upalabdhi*), Knowledge, (*jnána*), —these are not different in meaning.

(1). 'Not different in meaning,' i. e., synonymous, (*samánárthaka*).

(2). We characterise Mind, (*manas*).

*Aphorism XVI.*

The characteristic of the Mind is this, that there do not arise cognitions, (*jnána*), simultaneously.

(1). 'Simultaneously,' i. e, at one and the same time. You must supply "in one and the same soul." The meaning is, that, the 'characteristic' of, i. e., that whereby we recognise, the Mind, is the habit in virtue of which cognitions [more than one at once] do not arise.

(2). Gautama's opinion is, that what he calls the Mind, (*manas*), is an active internal organ, (*indriya*), of the size of an atom, (*paramáṇu*), and this, being conjoined with the soul, with whichsoever of the Senses it associates itself at any time, knowledge arises at that time through that Sense; and since it cannot be simultaneously in conjunction with more than one Sense, because of its being an atom, cognitions do not take place simultaneously. But *our* opinion is, that there belongs to the human Soul a certain natural *incapacity*, (*aśakti*), to grasp cognitions simultaneously,—and a soul thus distinguished is spoken of as a Mind.

(3). Now we have to state the definition of 'Improper Activity,' (*kupravṛitti*), which was enounced [in Aph. I.], and this will be understood clearly if we define Activity [simply]; so we define and divide Activity.

*Aphorism XVII.*

Activity, (*pravṛitti*), is an attempt, (*árambha*), of the Understanding, (*buddhi*), or of the Body, (*śaríra*).

(1). Gautama's aphorism is, that, "Activity is an attempt of the Understanding, the *Vocal organ*, (*vák*). and the Body." We have put in our aphorism that "Activity is an attempt of the Understanding or of the Body," intending thereby that "an attempt of the *Vocal organ*" ought not to be separately specified, since this is included under "an attempt of the Body." Further, as Activity is of two kinds inasmuch as it is Activity of the Understanding and Activity of the Body,—so also it is of two kinds through the division into proper, (*uchita*), and improper, (*anuchita*).

(2). Now, if we define 'Desire, &c.,' (*rágádi*), the definition of '*Improper* Desire, &c.,' [enunciated in Aph. I.] will be clear; therefore we define 'Desire, &c.'

*Aphorism XVIII.*

Desire, &c., (*rágádi*), have, as their character, that they actuate.

(1). 'Actuating,' (*pravartaná*), means being the cause of Activity. That of which such is the characteristic, is 'Desire, &c.' By the "&c.," (*ádi*), *Aversion*, (*dwesha*), is included.

(2). We define Mundane Life.

*Aphorism XIX.*

The conjunction of the soul with such bodies as we have here, constitutes Mundane Life, (*śánsárika jívana*).

(1). This is plain. We define Fruit [of Activity].

*Aphorism XX.*

Feelings, (*artha*), [—pleasurable or painful—] resulting from Activity, (*pravritti*), are the Fruit, (*phala*).

(1). We define Pain.

*Aphorism XXI.*

Pain, (*duhkha*), is that whose characteristic is distress, (*bádhaná*).

(1). 'Distress,' i. e., annoyance, (*píṛá*):—the meaning is that that is such, the characteristic whereof is this

(2). Now we set forth the Chief End of Man, with its cause.

*Aphorism XXII.*

The Chief End of Man is what is to be attained through the grace, (*prasáda*), of God.

(1). Gautama's aphorism here is, that, "Dismissal absolutely of that is Beatitude." The "that" refers to Pain, which had been mentioned just before. "Absolutely" means so that Pain may not again take place. 'Dismissal' means destruction;—and so the opinion of Gautama is, that, the Chief End of Man,—an annihilation of Pain such as must preclude the subsequent emergence of Pain,—is to be attained through a knowledge of the nature of things. But *our* opinion is, that, not merely such an annihilation of Pain is the Chief End of Man; because this has no attractiveness in itself, for it is an empty thing, inasmuch as it consists of a negation; but, in the Chief End of Man, something besides the annihilation of Pain is to be desired. Be that [something] what it may, it is, at all events, to be attained only through the grace of the Omniscient Maker of the world, the most merciful Lord God, by those who worship Him.

(2). Here ends the Section on the Objects [concerning which it is desirable that we should entertain right notions].

SECTION IV.—COMPLETING THE TOPIC OF THE PRE-REQUISITES OF REASONING.

(3). Now [the existence, &c., of] Soul, &c., the Objects [concerning which it is desirable that we should entertain right notions,] cannot be ad-

mitted merely on the strength of enunciation, (*uddeśa*), and definition, (*lakshaṇa*); therefore the demonstration of them is to be set forth. And this demonstration is in the shape of the employment of argumentation, and the initial element in argumentation is *doubt*;—therefore we define Doubt, which thus presents itself next in order.

*Aphorism XXIII.*

Doubt, (*sanśaya*), is [what results] from the perception of a sameness, [conjointly with] the non-perception of a difference, (*viśesha*), and the remembrance of a difference.

(1). That is to say,—Doubt arises 'from the perception of a sameness,'—i. e., from the apprehending of some concrete object which possesses characters common [to it with other objects]; and 'from the non-perception of a difference'—i. e, from the not discerning any character such as distinguishes [the object from all other objects];—and 'from the remembrance of a difference,'—i. e., from the taking into consideration some special character—such as the fact of being a post or the fact of being a man—[the remembrance of which alternatives keeps up the doubt so long as there is nothing to enable us to decide, in the dusk for instance, whether the object which appears to be of the height of a man is a man or a post].

(2). Now, since one makes no effort for the removal of doubt in the absence of a motive, we have next to define a Motive.

*Aphorism XXIV.*

'With an eye to what thing one energizes, that is a Motive, (*prayojana*).

(1). 'With an eye to what'—i. e., having regard to. So the meaning is this, that a motive is an object of desire, which [—whether the desire be to obtain it or to escape it—] is the cause of our acting.

(2). Now, since without instances, popular or scientific, nothing can be accounted for,—we define a popular instance, which presents itself next in order.

*Aphorism XXV.*

In regard to [some fact respecting] what thing both ordinary men, (*laukika*), and acute investigators, (*paríkshaka*), entertain a sameness of opinion, that [thing] is called a [familiar case of the fact in question, or a] popular instance, (*dṛishtánta*).

(1). Here, by 'ordinary men' we mean those who stand in need of instruction, and by 'acute investigators' those competent to instruct. Whatever thing they entertain a 'sameness of opinion'—i. e., no difference of opinion—regarding,—that thing may serve as a popular instance, [in regard to some particular question that may be under discussion]. So, what we intend to be understood by a 'popular instance' is anything which is a matter of certainty alike to proponent, (*vádi*), and opponent, (*prativádi*),—such is the import. As, for example, in proving that there is fire [in such and such a place,] the *culinary hearth*, (*mahánasa*), [will be accepted by every one in India as a familiar case of a locality where there is always fire]; and in proving that there is *not* fire [in such and such a place], a *deep lake*, (*mahâhrada*), [will be admitted to be a familiar case of a locality where fire is *not* to be met with].

(2). Here closes the topic of the pre-requisites of reasoning [—for, although scientific data—see Aph. XXIV, § 2.—are available, in the schools, as premises, yet these were first established by a process of argumentation].

SECTION V.—OF PROPOSITIONS, NOT FAMILIAR, THAT MAY BE EMPLOYED IN REASONING WITHOUT REQUIRING TO BE EACH TIME DEMONSTRATED.

(3). We define a scientific 'tenet,' which comes next in order.

*Aphorism XXVI.*

A 'tenet' (*siddhánta,*) is that, the steadfastness of the acceptance of which rests on an institute, (*tantra*).

(1). We divide [' the tenets' thus characterised generally].

*Aphorism XXVII*

Tenets are divided [into the species that are described in the succeeding aphorisms] through the difference between a 'Dogma of all the schools,' *sarva-tantra-siddhánta*), a 'Dogma peculiar to some one or more schools,' *prati-tantra siddhánta*), 'a Hypothetical Dogma, (*adhikaraṇa-siddhánta*), and an 'Implied Dogma,' (*abhyupagama-siddhánta*).

(1). We define a 'Dogma of all the schools.'

*Aphorism XXVIII.*

That [position or tenet] which is not in opposition to any of the schools, (*tantra*), and which is advanced [as a tenet] by [at least] some one school, is [what we mean by] a 'Dogma of all the schools,' (*sarva-tantra-siddhánta*).

(1) [Such a tenet of all the schools, or of all systems of doctrine, is] e. g., the fact that *odour* is to be apprehended by the sense of *smell.*

(2). We define a 'Dogma peculiar to some school.'

*Aphorism XXIX.*

That [position] which is [held] established in the same school, and which in another school is [regarded as] not established, is [what we mean by] a 'Dogma peculiar to some school,' (*prati-tantra-siddhánta*).

(1). Such, for example, is [at present] the European tenet of the earth's motion.

(2). We define the 'Hypothetical Dogma'.

*Aphorism XXX.*

That, if which be [held] established, [—and not otherwise—] there is the establishing of another point, is [what we mean by] a 'Hypothetical Dogma,'. (*adhikaraṇa-siddhánta*).

(1). For example, when it is to be established that the world was *produced,* the Omniscience of God [must be assumed in order to account for its production].

(2). We define an 'Implied Dogma'.

*Aphorism XXXI.*

The mention of some particular character [which mention, by the leader

of a school, could have arisen only] from his holding some opinion which he has not anywhere declared aphoristically, constitutes an 'Implied Dogma' (*abhyupagama-siddhánta*).

(1). Thus, for example, Gautama [by speaking of the Mind as one of the *instruments* of knowledge] implies that he reckons the Mind among the *organs* [of the Soul, although he nowhere explicitly lays down this tenet in an aphorism].

(2). Here ends the topic of the definition of 'tenets' that take their place in argumentation.

### SECTION VI.—THE METHOD OF ARGUMENTATIVE EXPOSITION.

(3). With a view to defining, we divide, the members [of a demonstration] which present themselves next in order [of the topics enumerated in the first aphorism].

*Aphorism XXXII.*

The members, (*avayava*), [of a demonstration] are (1) the Proposition, (2) the Reason, (3) the Example, (4) the Application, and (5) the Conclusion.

(1). We define the Proposition, (*pratijná*).

*Aphorism XXXIII.*

The Proposition is the declaration of what is to be established.

(1). For example—the assertion of the globularity of the Earth [—in the proposition "The Earth is globular."]

(2). We define, and, by [reference to] the two subsequent aphorisms, divide, the Reason, (*hetu*), which presents itself next in order [of the things enumerated in Aphorism XXXII].

*Aphorism XXXIV.*

The Reason is the means for the establishing of what is to be established; [and this force it may derive either] from the Example's having a character which involves another, or [conversely] through the Example's wanting a character the want of which involves the absence of another.

(1). Here the generic definition is this—that 'the Reason is the means for the establishing of what is to be established.' That a Reason may be of *two* kinds, is declared in the assertion that it derives its force as an argument, (1) from the Example's having a character which involves another, or (2) from the Example's wanting a character the want of which involves the absence of another. For example, [we may assign as a Reason for the Proposition that 'The Earth is a globe'] the assertion—'Because its shadow [on the Moon] is [invariably] circular,'—and [this we may allege as standing in relation to the Universal Affirmative that] 'whatever has an invariably circular shadow is seen to be a globe,—as is the case with a billiard-ball, for example.' And again [we may assign as a Reason, in support of the foregoing Proposition, the same assertion as before—viz.,] 'Because its shadow is invariably circular,' and [this we may allege as standing in relation not as before to a Universal Affirmative but to the following Universal Negative, viz.,] "Nothing which is not a globe casts invariably a circular shadow,"—as a post, for instance.

(2). We have now to define the 'Example,' (*udáharaṇa*), which presents itself next in order [ of those enumerated under Aph. XXXII].

*Aphorism XXXV.*

The Example is some [undisputed] instance which, through a character invariably attended by what is to be established, makes us recognise that character which is to be established.

(1). For example—every thing which invariably casts a circular shadow is globular—'as is a billiard-ball,' [ which invariably casts a circular shadow;—here the instance causes us to recognise globularity in the case of whatever possesses the character of invariably casting a circular shadow ].

(2). [ But the 'Example,' as already remarked, may be of two kinds; so ] we now define the Example in which some two given characters [instead of being both present ] are both concomitantly absent.

*Aphorism XXXVI.*

Or the Example, contrariwise, by [showing] a consociated absence thereof [—i. e., of the Reason, where what is to be established is not present—], is a negative one.

(1). For instance—'Nothing which is not a globe casts invariably a circular shadow,—as a post, for example, [—or as a circular disc, which, not being a globe, does not invariably cast a circular shadow, though it may do so in certain positions ].

(2). We define the 'Application,' (*upanaya*), which presents itself next in order [of those enumerated in Aphorism XXXII].

*Aphorism XXXVII.*

The 'Application' is the re-statement of that in respect of which something is to be established,—as being *so* or *not so*, as regards the 'Example.'

(1). That is to say, this Member [ of an argumentative exposition ], the Application, is the 're-statement,' or mention, of 'that in respect of which something is to be established',—i. e. [in respect of] the Subject of the proposition, 'as regards the Example',—i. e. in accordance with the [affirmative or negative character of the] Example. It is of two sorts, through the division into that which speaks of a consociation of affirmatives, and that which speaks of a consociation of negatives.

The re-statement of the Subject in the form of—'And this is so' has reference to an affirmative Example:—e. g, 'And this Earth is so, [—when the Major Premiss runs thus—'Whatever is possessed of a shadow invariably circular is a globe—as a billiard-ball is']. The re-statement in regard to the Subject takes the form of 'And this this is *not* so,'—when it has reference to a negative Example. [Thus the re-statement may be 'And this Earth is *not* so'—when the Major Premiss runs thus—'whatever is not globular is not possessed of a shadow invariably circular,—as a post, for example;'—but 'this Earth is *not* so,' for the Earth *has* a shadow invariably circular].

(2). We define the 'Conclusion', (*nigamana*).

*Aphorism XXXVIII.*

The 'Conclusion' is the re-statement of the 'Proposition' [as being now authorized] by the mention of the 'Reason.'

(1). For example, [our conclusion may be] 'Therefore [—i. e. for that Reason—] the Earth is a globe.'

(2). Here concludes the topic of the nature of argumentative exposition.

SECTION VII.—CONCLUDING THE TOPIC OF DEMONSTRATION.

(3). [But, thus far, we have been shown an arrangement for hearing only one side of the question, and how can we be sure that the opposite is not the right one? Before making up our minds we must hear both sides. Next, therefore, before defining 'Ascertainment,'] we define the 'Confutation', (*tarka*), of objections.

*Aphorism XXXIX.*

'Confutation' is an argumentation, for the ascertaining of the truth in regard to any thing the truth in regard to which is not thoroughly discerned;—from the presence of the reason [which would not be present if that which is to be established were not present].

(1). [In other words, the confutation of him who denies the conclusion of a sound argument while he admits the premises, consists in our directing him to look at it from an opposite point of view. To one who admits that the Earth's shadow on the Moon is invariably circular, and that what casts a shadow invariably circular must be a globe, but who still hesitates to admit that the Earth is a globe, we remark]—for example—'If the Earth were *not* a globe, it would not have a shadow invariably circular.'

(2). We define 'Ascertainment,' (*nirṇaya*), which presents itself next in order.

*Aphorism XL.*

'Ascertainment' is the determination of a matter by dealing with both sides of the question, after having been in doubt.

(1). That is to say—'Ascertainment' is the settling of the question by the establishing of one's own view of it and the confuting of the other view.

(2). Here concludes the topic of the supplements to argumentation.

SECTION VIII.—THE TOPIC OF DEBATE.

(3). An honest enquirer after truth, even after confutation [of his objections], may perhaps not arrive at certainty without the aid of Debate;—therefore we define Debate, (*váda*), which comes next.

*Aphorism XLI.*

'Debate' is the undertaking [—by two parties respectively—] of the one side and of the other, in accordance with the five-membered [process of demonstration already explained;—this discussion] consisting in the defending and assailing [of the proposition] by proofs and confutations, [—the debate being conducted on both sides] without opposition to the tenets [or principles which both disputants hold in common, and on which the conclusion is to depend].

(1). Since those who, under the pretence of seeking the truth, are dishonestly eager for victory, will *wrangle*, we next define 'Wrangling,' (*jalpa*).

*Aphorism XLII.*

'Wrangling,' conducted [in regular form] as aforesaid [—i. e., as specified in Aph. XLI—] consists in the defence or attack [of a proposition] by means of 'Frauds' [—see Aph. L.—], 'Futilities' [—see Aph. XLVIII.—], and 'What gives occasion for rebuke' [—see Aph. LIX.—].

(1). So—'Wrangling' is a discourse for the sake of victory, whichever side of the question it establish.

[2). Disingenuous persons who have not sufficient skill for 'Wrangling' [—which implies the possession of sufficient skill to take up a position and maintain it—], have recourse to *cavilling*. We next, therefore, define 'Cavilling,' (*vitaṇḍá*).

*Aphorism XLIII.*

This [—viz., 'wrangling'—], when devoid of [any attempt made for] the establishing of the opposite side of the question, constitutes 'Cavilling.'

(1). Here the topic of 'Controversy' is concluded.

SECTION IX —OF FALLACIES, OR WHAT ONLY LOOK LIKE REASONS, BY MEANS OF WHICH A MAN MAY DECEIVE HIMSELF OR ANOTHER.

(2). Now, wranglers and cavillers, when they do not find good reasons to support their positions designedly make use of what merely *look* like reasons. For the rebuke of these, and, inasmuch as even honest enquirers, through their ignorance of the nature of the Semblances of a reason, may make use of such;—we define and divide the 'Semblances of a reason,' (*hetwábhásá*), which present themselves next in order [of the topics enumerated in the first Aphorism].

*Aphorism XLIV.*

The 'Semblances of a reason' are (1) the 'Erratic,' (2) the 'Contradictory,' (3) 'That which leaves the matter in suspense' [or in equilibrio], (4) that which is 'In the same case with what is to be proved,' and (5) the 'Mistimed.'

(1). We define the 'Erratic,' (*savyabhichára*).

*Aphorism XLV.*

That [semblance of a reason] is 'Erratic' which attends not merely the one [character, which it is employed to prove, but attends also the absence of that character].

(1). E g , "The mountain must smoke, because there is fire in it."

(2). We define the 'Contradictory,' (*viruddha*), [semblance of a reason], which, comes next in order.

*Aphorism XLVI.*

That [semblance of a reason] is called 'Contradictory' which would prove the reverse in regard to what is to be established.

(1) For example, "This must be fiery,—because it is a body of water."

(2). We define that semblance of a reason 'which leaves the matter in suspense' (*prakaraṇasama*),—this presenting itself next in order.

*Aphorism XLVII.*

That [alleged reason] from which a question may arise as to whether the case stands this way or the other way, if propounded with the view of determining the state of the case, is 'that which leaves the matter in suspense.'

(1). For example "Sound is eternal, because it has the nature of Sound;" [—to which it may be retorted—] "Sound is *not* eternal, because it is a made thing"

(2). We define that semblance of a reason which is 'In the same case with what is to be proved,' (*sádhyasama*),—this presenting itself next in order.

*Aphorism XLVIII.*

And it [—the alleged reason—] is 'In the same case with what is to be proved,' if, by its standing itself in need of proof, it does not differ from that which is to be proved.

(1). We define the 'Mistimed,' (*kálátíta*), semblance of a reason,—which comes next in order.

*Aphorism XLIX.*

That [semblance of a reason] is said to be 'Mistimed' which is adduced when the time is gone by [when it might have availed].

(1). For example,—"Fire does not contain heat, because it is factitious,"—[here the argument is 'Mistimed,' if we have already ascertained, by the superior evidence of the senses, that fire—granting it to be factitious—*does* contain heat].

(2). Here concludes the topic of the Semblance of a reason.

SECTION X.—OF THE TRICKS EMPLOYED BY THE DISHONEST DISPUTANT TO THWART THE OTHER PARTY.

(3). We remarked that an honest enquirer may, inadvertently, employ the semblance of a reason as a real one; but what we have next to define are the tricks which are employed only by the dishonest disputant.

*Aphorism L.*

'Unfairness' is the opposing of what is propounded, by means of assuming a different sense [from that which the objector well knows the propounder intended his terms to convey].

(1). We divide 'Unfairness,' (*chhala*).

*Aphorism LI.*

It [—viz. 'Unfairness'—] is of three kinds, (1) Fraud in respect of a term, (2) Fraud in respect of a genus, and (3) Fraud in respect of a trope.

(1). We define 'Fraud in respect of a term,' (*vák-chhala*).

*Aphorism LII.*

'Fraud in respect of a term' is the assigning a meaning other than [the objector well knows] was intended by the speaker when he named the thing [by a term that happened to be ambiguous], without distinguishing.

(1). For example,—if some one says "A cow (*gau*) has horns,"[—a caviller, recollecting that the word *gau* is explained in the dictionary to mean an elephant as well as a cow, may exclaim—] "Whence has an *elephant* horns?"

(2). We define 'Fraud in respect of a genus,' (*sámányachchhala*).

*Aphorism LIII.*

'Fraud in respect of a genus' is the asssuming something [to be asserted which is] impossible, by an undue employment of its homogeneousness with that of which the fact asserted *is* possible.

(1). For example, on some one's saying, "This is a 'Bráhman,'—he must be possessed of learning and conduct;"—the other, [assuming that he here deduces the possession of learning and conduct from the fact of being a Bráhman, says—'How?—for, the possession of learning and conduct, if 'deducible from the fact of being a Bráhman, would be found, where it cannot, in his *childhood*.' [The other, of course, mean*t*, as the objector very well knows, to speak of a Bráhman who has lived long enough in the world to render it possible for him to study, in which case the probability is that he will have studied].

(2). We define 'Fraud in respect of a trope,' (*upachárachchhala*).

*Aphorism LIV.*

'Fraud in respect of a trope' is the denial of the truth of the matter, when the assertion was made in one or other of the modes, [viz., literal or metaphorical,—which it suits the purpose of the objector to invert].

(1). For example, when it has been asserted that "The scaffolds cry out" [—somewhat analogously to the English phraseology "The pit and gallery applaud"—a dishonest opponent will say] "It is only *those standing* on the scaffolds that cry out" [—as if the other had meant to make the assertion literally of the scaffolds].

(2). As the point here occurs, he states a primâ facie view in regard to 'Fraud in regard to a trope.'

*Aphorism LV.*

'Fraud in respect of a trope' [—some one may fancy at first sight—] is just 'Fraud in respect of a term,' for it does not differ therefrom.

(1). The meaning [of this objection] is, that Fraud is of only two kinds, [not of three kinds; for Fraud in respect of a trope is just Fraud in respect of a word, seeing that these agree in the assumption that some word was employed in another sense than that in which it was well enough known that the speaker did employ it].

(2). This objection we clear up.

*Aphorism LVI.*

It is not so [as the objector in Aphorism LV. supposes], because they *do* differ.

(1). We state what debars the opposite view.

*Aphorism LVII.*

Or if there were no distinction where there is *any* similarity of character [—as there no doubt is between the two species of Fraud, under consideration—] then we should have only *one* kind of Fraud, [while the objector himself holds that there are *two*].

(1). Here concludes the topic of Fraud in disputation.

SECTION XI.—OF FUTILE OBJECTIONS AND HOPELESS STUPIDITY.

(2). We define 'Futility,' (*játi*), which presents itself next in order.

*Aphorism LVIII.*

Futility consists in the offering of objections founded on [some mere] similarity or difference of character [—without regard to the question whether the fact asserted bears any invariable relation to that character]

(1). The meaning is this, that Futility consists in objecting, or taking exception, on the ground of similarity or difference of character *without respect to invariableness of association* [between the character and that whereof it is taken as a sign of the presence or the absence. For example, if it were propounded that 'The man is unfit to travel, because he has a fever,' it would be futile to object that 'The man *is* fit to travel, because he is a soldier'—there being no invariableness of connection between the being a soldier and the being fit to travel].

(2). We define 'Occasion for rebuke, (*nigrahasthána*),—the topic which presents itself next in order.

*Aphorism LIX.*

'Occasion for rebuke' consists in one's [stupidly] misunderstanding, or *not* understanding at all.

(1). [The term here rendered, Occasion for rebuke, signifies literally the place, i. e. the occasion for, or the suggester, of rebuke ;—for if a man stupidly misunderstands you or does not understand you at all, and yet still persists in trying to make a show of opposition, then the matter has come to that point where there is room left only to rebuke him and drop the discussion]. In order to obviate the mistake, [into which some might fall, of supposing] that there is no subdivision of Futility and Unfitness to be reasoned with, [—the subdivisions of which will be stated in their proper places—] we remark as follows.

*Aphorism LX.*

'Since each of them is of different kinds, 'Futility' and 'Occasion for rebuke,' are of various descriptions.

(1). For fear of prolixity, the subdivision is not made here.

(2) Here ends the first Book of the Synopsis of Science,—which consists of an exposition of the agreements and the disagreements between the list of things as asserted by Gautama and the list of things held as established by the modern Europeans.

A

# SYNOPSIS OF SCIENCE.

## BOOK II.

### INTRODUCTION.

(1). THUS, then, in the First Book, we have concisely shown the agreement and the disagreement between Gautama's opinion and our own, in regard to the enquiry—what is the Chief End of Man, and what are the means of its accomplishment.

(2). Now we proceed to set forth the chain of the sciences, in the order which we ourselves have adopted.

(3). Since the determination of every object of right cognition is dependent on its *evidence*, what presents itself as now appropriate is the discussion of the varieties of Evidence, (*pramána*) enunciated in Book I, Aph. I, and divided in Aph. III, in the order of that division :—therefore, first, we set forth the Senses, the Smell, &c., which constitute the direct instruments of knowledge, and which, in Aph. XII, were divided into five. And in the section regarding each Sense, we shall state, in regard to their Objects, viz., Odour, (*gandha*), Savour, (*rasa*), Colour, (*rúpa*), Tangibility, (*sparśa*), and Sound, (*śabda*), only what has been well ascertained by examination.

#### SECTION I.—OF THE SENSES AND THEIR OBJECTS.

(4). We define the Sense of Smell, (*ghráṇa*), the one first enounced.

*Aphorism I.*

The Sense of Smell, residing in the nose, is that power which gives rise to the cognition "I smell."

(1). When particles of odorous things enter the nose by inhalation, then that power in virtue of which, located in that part of the body, the cognition, in the absence of counteracting causes, that "I smell" arises, is the Sense of Smell.

(2). The Object of the Sense of Smell is Odour ; and that is such a sort of power as that the cognition "I smell" takes place on the conjunction of things possessing that power with that part of the body which possesses the power termed the Sense of Smell. And consequently the possession simply of such a sort of power is what we speak of as odorousness. But there is no necessity that odorousness should belong to *earth* only [as Gautama insists]; because there is no advantage in giving the name of earth, on the

strength of such a determination, to Chlorine-gas, &c.,—elementary bodies possessing pungent odour; and because, in any science, it is incumbent on us to have reference to some *utility* in the speaking about such and such things under such and such names.

(3). It is in the section on Chemistry that we are to learn those words and things where the designating of each thing severally by each word is conducive to the promotion of the good of society.

(4). Now we define the sense of Taste, (*rasana*), which presents itself next in order.

*Aphorism II*

The sense of Taste, residing in the tongue, is that power which gives rise to the cognition "I taste."

(1). Sapid bodies, having entered the mouth, when, being dissolved by conjunction with the water of the mouth, they come into contact with the tongue, then, in the absence of obstructing causes, there arises the cognition that "I taste." The Object of the Sense of Taste is Savour. The nature of this, just like the nature of Odour already mentioned, is to be understood to consist in a specific *power*.

(2). Now we define the Sense of Sight, (*chakshush*), which comes next in order.

*Aphorism III.*

The Sense of Sight, residing in the eye, is that power which gives rise to the cognition "I see."

(1). To explain:—possessed of the power of causing cognizance of whichsoever colour, the light, coming from any body, whether self-luminous or illuminated, enters the eye, there arises a visual cognition of that body as being distinguished by that same colour. The Object of the Sense of Sight is Colour. The nature of Light, the relation of Light to Colour, the particular conditions of Light which result from its contact with different substances, and the structure of the Eye, will be discussed in the section on Optics.

(2). Now we define the Sense of Touch, (*twach*), which comes next in order.

*Aphorism IV.*

The Sense of Touch is that power which gives rise to the cognition "I feel:"—though residing in the whole body, its highest manifestation is in the tips of the fingers.

(1). Now we define the Sense of Hearing, (*śrotra*), which comes next in order.

*Aphorism V.*

The Sense of Hearing, residing in the ear, is that power which gives rise to the cognition "I hear."

(1). The cognition "I hear" is produced by vibration, such as is conducive to hearing, in a membrane within the ear, called the drum of the ear. The Object of the Sense of Hearing is Sound. The nature of Sound,

how the particular vibration of the body in the place where the Sound arises, produces, through the air, &c., vibration in the drum of the ear, and the structure of the ear, will be discussed in the section on Acoustics.

(2). Thus have the five Senses been described, together with their five Objects. Now, of *Distance*, which the vulgar imagine to be an object of direct cognition, we state what it is that really informs us.

*Aphorism VI*

The knowledge of distance is from inference, not from direct cognition.

(1). To explain :—that thing of which the colour and the parts appear indistinct, and the size of which is perceived as less than its previously ascertained real size, is inferred to be distant. For example; by a person who has gone into a house, a palm-tree, on the further bank of the Ganges, of twenty cubits in height, being beheld through a window of a single cubit in size, first appears of smaller size than the size of the window, and its colour, and its parts, the branches, leaves, fruits, &c., appear indistinct; therefore its real distance is inferred on the instant. Or, again, when a crow, which is near us, appears indistinct in consequence of the interference of mist, if it is not taken to be a crow but to be an elephant, then it is inferred, from our cognizing it as of smaller size than the previously ascertained size of an elephant, that it is a very distant elephant —but on its being cognized as a crow, its real nearness is apprehended. But where the true size has not been previously ascertained, and the perception is not indistinct, there is no certainty regarding the real distance, e. g., in the case of the sun, moon, and stars. For the real size of these was not known at first, and they are not perceived indistinctly, because of their great brilliancy; therefore [—according to the decision of the Hindús—] the common impression of all men is, that the sun and the moon are a long span in measure, and the stars of the size of the fruit of the myrobalan. Hence also they are all apprehended as at an equal distance from the earth; whence the distribution of the stars appears as if it were upon a sphere.

(2). The vulgar belief that the distance of the cause of a sound is apprehended by the Sense of Hearing, is in like manner based on want of consideration. To explain :—if the perception of the sound could of itself make us understand whether it has arrived from a distance or from the vicinity, how could the doubt ever arise whether it were the rumbling of a cart or the thundering of a cloud? Therefore we must hold as follows. If it be known from what causes severally the sounds arise, then, by their loudness or their softness, which is the object of cognition by the Sense of Hearing, the nearness or distance of its cause is inferred. For example, if any one, in the night, hearing a very soft sound, learns from the speech of a friend that it is the thundering of clouds, then he infers that the clouds are very far off. But when there is no certainty as to what cause it has arisen from, then doubt arises, from the cognition of the loudness or the softness, &c. And so in both cases [—those of Sight and Sound—], it is clear that distance is learned only through inference.

(3). But then, *five* Senses have been described, under the division of Smell, Taste, Sight, Touch, and Hearing:—if it be asked why, when these are brought in contact with their respective objects, through the special parts of the body [appropriated to the residence of the Senses], a pentad of cognitions does not arise simultaneously,—then, in regard to this, the fol-

lowers of Gautama say that a simultaneousness of cognitions cannot be, because the cause of cognition is not barely the approximation of the Sense to its Object, but when the Soul, (*átman*), is conjoined with the Mind, (*manas*), the mind with the Sense, and the Sense with the Object, *then* cognition arises:—even though it is possible that there should be simultaneously many approximations of Senses to their Objects, yet, since it is quite impossible for the Internal Organ, the Mind, which consists of an atom, to be simultaneously in conjunction with more Senses than one, there is no simultaneousness of cognitions. But the moderns of Europe say that what is called the Mind is not an Internal Organ distinct from the Soul, but the Soul itself, existing as limited by this body [of ours], is to be spoken of, for shortness, by the word Mind;—and that to a Soul so conditioned does not belong the power of having simultaneously more cognitions than one; and thus, even where there is an approximation of several Senses to their Objects, yet, through the fact that a kind of natural powerlessness [to take cognizance of more than one Object at a time] stands in the way, there is no simultaneousness of cognitions.

(4). Now, there belong to the Soul, as limited by the body, several kinds of special qualities. We exhibit these concisely.

*Aphorism VII.*

Pleasure, Pain, Attention, Memory, &c., are special qualities of the Mind.

(1). A diffuse account of these qualities is to be looked for in another book.

(2). Now, in connection with what we asserted, viz, that the ascertainment of Distance is through Inference, (*anumána*) not from direct cognition, in order to set forth Inference, thus presenting itself next in order, we commence, next after the section on direct cognition, a section on Inference. Its sub-sections are four,—the first the section on the method of apprehending invariable attendedness [of one nature by another,—i. e., Induction]; the second the section on [the employment of] an induction for oneself [—i. e., Deduction—]; the third the section on [the employment of] an induction for another [—i. e, Demonstration,—the business of Rhetoric properly so called—]; the fourth the section of Debate [—occupying the ground of Formal Logic]. In the first place we define, by an aphorism, the nature of an induction.

## Section II.—The Method of Induction.

*Aphorism VIII.*

An induction is an ascertainment of invariable attendedness (*vyápti*) [of some nature by some other].

(1). Now, since such invariableness of attendedness cannot be ascertained without a method, the method is to be set forth; and this consists not in the merely cognizing this or that thing, since this, without reflection, leads to nothing; nor, moreover, does it consist in mere reflection, without direct cognition of the properties of things,—since this also leads to nothing;—but the two together, mutually cooperating, are the means:—with reference to this we declare—

*Aphorism IX*

The root of it is direct cognition, and reflection.

(1). 'Of it', i. e., of an ascertainment of an invariable attendedness.

(2). Now we divide direct cognition, which is the root of an ascertainment of invariable attendedness.

*Aphorism X.*

Direct cognition is of two kinds, (1) Observation, (*pratíkshá*) and (2) Experiment (*paríkshá*).

(1). '*Observation*' is the beholding, with steady attention, this or that phenomenon, without our having operated with a view to the production of the phenomenon which we desire to behold:—*e. g.* in such a case as that of an eclipse of the sun or moon; for, in that case, the eclipse, which results from a particular disposition of the sun and moon at this or that time, which disposition cannot be brought about by one's own efforts, can be *beheld* only,—so that this instance is one of *Observation* simply.

(2). '*Experiment*' signifies the beholding of such and such phenomena produced by our having operated with a view to the production of the phenomenon which we desire to behold:—*e g.*, when we wish to know the character of Sulphur, Salt, &c., in respect to Fire or Water, having brought Sulphur, &c, into conjunction with Fire, &c., we view the phenomena which result therefrom;—so this is an instance of *Experiment.*

(3). But then, some one may say,—since 'Observation' and 'Experiment,' which have been just mentioned, are things well known in the world, what need of a treatise to teach us these things?—so, wishing to repel this doubt,—holding that even though both of these *are* familiarly known, yet, since it is *not* familiarly known how we ought to act in regard to them, a treatise *is* useful, since it is necessary to set forth, as included under the head of what we ought to do, the means of directing and strengthening the understanding;—with an eye to this, we state that the Understanding has need of its proper helps.

*Aphorism XI.*

As in external operations, the hands, &c., have need of their several helps, it is quite certain that the Understanding, in its own operations, has need of helps.*

(1). '*Quite certain*' &c.—Not so many properties as are produced in some product when all the helps are available, are produced in the absence of the helps:—for the qualities in a jar formed by the bare hand are by no means equal to those in one formed by the hand supplied with all the helps, such as staff, wheel, rag, water &c. If they *were* exactly equal, then the numerous kinds of instruments, formed of various metals and woods, would be purposeless:—so much is beyond dispute. And so it may be inferred that the Understanding, in the production of great works, requires helps, since in its unaided condition it can produce but small results, just like the hand. But those helps of the Understanding shall be described in the sequel.

(2). Now, as, in the case of Observation, the *beholding* merely of this

* Bacon's Novum Organum, Aph. 2.

or that phenomenon is possible, so again, in the case of Experiment, man has no power whatever over any portion of the *result*, but can only watch the result of this or that;—but the difference between the two cases is this, that, in the case of Experiment, it is possible to bring together or to separate the things which conduce to the result,—as we state as follows.

*Aphorism XII.*

By Man, employed in operating towards a result, nothing whatever can be done besides conjoining or disjoining extant things, because the result is dependent upon Nature alone.*

(1). '*Because it is dependent upon Nature alone*':—because it is dependent upon Nature (*prakṛiti*) alone, i. e. the will of God, and the nature of the world, such is the meaning.

(2). Now, in order to show more strongly the necessity that the Understanding should be provided with helps conducive to the knowledge of truth, we state what mischief arises when investigation is carried on by the Understanding destitute of helps.

*Aphorism XIII.*

Usually, in all the divisions of knowledge, *this* is the root of the great paucity of fruit, that enquirers, neglecting the search for means conducive to the reinforcement of the Understanding, act under a conceit that the power of their own Understanding is supernatural. †

(1). The import is as follows. If a painter, through excessive conceit of his own skill, not having looked at all at the object, undertakes to make a copy of it, then, as his conceitedness and incorrect conduct is evident,—so too, if an enquirer, fancying himself able to fathom the course of Nature by the aid of mere Thought should treat disrespectfully Observation and Experiment, the nature of which has been described, then *his* conceitedness and incorrect conduct also must be evident,—and how should *he* attain to such science as should have for its fruit the knowledge of the truth in regard to all things?—not in *any* way,

(2). Now we state, that in consequence of the extreme subtilty of the facts of nature, it is impossible that the knowledge of all truths should ever be arrived at by the mere Understanding of men, though excessively sharp-witted and exceedingly devoted to meditation.

*Aphorism XIV.*

In comparison with what subtilty, belonging to things, the mere Senses and the mere Understanding can realize or conceive, the truth of Nature is more subtile still; so that those meditations and disputations which are undertaken without regard to the proper method of learning the truth, are all quite useless, through their having no tincture of the truth of Nature; and yet the discerning of their inutility is not possible without great reflection in accordance with the correct method of discovering truth.‡

(1) '*The truth of nature is more subtile still.*' For example, in ancient times there were many thousand sages always devoted to the investigation

*Novum Organum, Aph. 4. † Novum Organum, Aph. 9
‡ Novum Organum, Aph. 10.

of the truth in regard to Nature, and these were all supporters of the opinion, common to uninstructed persons, and really false, though [seemingly] corroborated by the direct evidence of Sight and Taste, that Water is an elementary substance:—and the reason of this was, that those sages, feeling certain that it was possible to ascertain the truth in regard to Nature by means of the unaided Senses and Understanding, did not avail themselves of the proper helps of the Senses and the Understanding, when the knowledge of the whole truth in regard to Nature was under enquiry. By modern philosophers on the other hand, enquiring daily into the truth in regard to this or that substance, with the aid of Observation and Experiment, it has been settled that Water consists of two kinds of Air combined; therefore it is evident that all the disputations proceeding on the assumption of the ancient opinion just mentioned must have been useless, since the fact is that Water has been ascertained, by thousands of observations aided by Experiment, to be a compound body;—and this could not be really learned without investigating rightly.

(2). But then, if it be difficult,—neglecting Observation and Experiment, to learn the truth of Nature, then those who, though they never observed or experimented, are yet held to possess much knowledge of natural truth,—pray, were these quite in *error*? if you ask this,—we reply as follows.

*Aphorism XV.*

There is a great difference between those semblances of real natures, fancied to be true, which are the objects of human knowledge, and [on the other hand] the real characters, residing in this or that set of things, which constitute the object of the Divine knowledge that is in every part accordant with the things.*

(1). Well then, the question being—how knowledge of truth is to be obtained,—two methods present themselves. Of these the one is not proper to be adopted, because it is not good,—but the other is to be followed, because it is good;—in order to intimate this, we impose two names, suggestive of goodness and badness, to facilitate the dealing with those two.

*Aphorism XVI.*

The method naturally followed by every body, which is rash and premature, is called the Anticipation of Nature; (*prakṛityágraha*) but that method which leads to ascertainment of the truth in regard to the real and important properties which belong to this or that thing, is called the Interpretation of Nature (*prakrityadhyayana*).†

(1). But then, if the Anticipation of Nature be bad, why is it generally employed by men? If this be asked, we reply, that it is because it is calculated to win men's minds by its calling for little exertion.

*Aphorism XVII.*

The Anticipation of Nature is more potent to subdue men's minds, because the things to which it attends, from being the objects with which one is daily conversant, are familiar and few, and therefore enter the understanding quickly, without requiring any great application of mind: but this is

* Novum Organum, Aph. 23. † Ibid, Aph. 26.

not the case with the Interpretation of Nature, for the things to which *it* attends are not calculated to enter the understanding quickly, since they are in general hard for people to understand, because, from their being mutually unlike, they do not mutually suggest each other, and are not of a limited number; nay, rather, they generally appear to men's minds nothing to the purpose, through the influence of contrary views previously taken up.*

(1). It may be made clear by the example of Dew, how the Anticipation of Nature is calculated, as stated in this aphorism, to subdue men's minds, and how the Interpretation of Nature, through the influence of previous impressions, is taken to be nothing to the purpose. Thus:—when the night has passed with the sky free from clouds, and with all the host of the stars clearly apparent, in the morning perceiving that the ground, in places unsheltered by trees, houses, &c, is wet with water, it is generally supposed, by all conjecturers, that the water has fallen from the sky or from the stars. And this,—from its being easily apprehended, because the materials of the explanation, *viz.*, clouds, sky, stars, night, morning, trees, houses, water, &c., are matters with which we are daily conversant,—having readily entered the understanding, produces satisfaction,—by removing all question as to the cause of Dew. Thus we see that the *Anticipation of nature* has power to subdue the understanding. But in reality, by Experiment, the cause of Dew is proved to be something entirely different. Whenever anything becomes colder than the moist air around it, then a portion of the water that is suspended in the air settles upon it, and is called Dew. Thus, there is no such Dew on the surrounding ground as settles on the masses of hair cut off and left lying by the pilgrims at Allahabad and elsewhere. If the Dew fell from the sky, then why should it not fall also all around?—and why too, by day, should Dew appear on a mirror when breathed upon?—or why should Dew appear on a glass vessel filled with very cold water?—or why, in the season of the rains, should Dew appear upon the inner side of the glass doors—within the house?—for in these instances this can have no connection with water fallen from the sky, or with the rain:—but it may be rightly asserted that the water suspended in the air, breath &c., settles upon them because all these, *viz.*, the mirror, &c., are colder than the surrounding air, and this is the real cause of Dew. But this, as it is based on numerous and mutually unconnected instances, *viz*, the hair, mirror, glass, &c., is difficult to understand without careful study; and, through the force of the habitual impression of the truth of the previously accepted doctrine, it appears quite erroneous:—so that it is clear how the *Anticipation of Nature* is [the more generally acceptable] as was said before. There are numerous instances [which concur to establish the validity of this theory] of Dew; but these we shall treat of fully when discussing the *Method* of Induction; [—whereas we are at present engaged in removing certain popular delusions which are calculated to prevent an unprejudiced consideration of the Method].

(2). It has been already declared [Aph. XV] that there is a great difference between those semblances of truth which constitute men's notions, and the real natures of things as known to God. To make this clear, we define generally, and divide, the ['semblances of real natures', or human] *Fancies*.

* Novum Organum, Aph. 28.

*Aphorism XVIII.*

The obscurers of the mind, the *Fancies*, (*swarúpábhásá*), are fourfold, (1) of the tribe, (*játikṛitá*), (2) of the cave, (*guhákṛitá*), (3) of the market, (*paṇyavíthikṛitá*), and (4) of the theatre, (*rangabhúmikṛitá*).*

(1). Here the generic definition is 'obscurers of the mind'. By 'obscuring,' we mean preventing the knowledge of the truth. [Fancies or] 'semblances of true nature',—*i. e.*, what seem, or are fancied by people to be, like true natures,—like the real character of things:—in short, *unreal* characters, the objects merely of false notion; *e. g.*, the [fancied] elementary character of water, the atmosphere's [fancied] want of weight, &c.

(2). Here the word 'tribe' means something like a tribe—*i. e.*, a disposition common to all human beings. The word 'cave' means something like a cave, *i. e.*, the modification of the mind of this or that individual man. The word 'market place' means in like manner the verbal intercourse that belongs to ordinary affairs. So the word 'theatre' means books of doctrine. To be a fancy of the tribe, means, to be the object of a false notion originating in the common nature belonging to all the human race, the characteristic of which is among other things, to attach more importance to affirmative instances than to negatives,—*e. g.*, men believe in astrological predictions, dreams, and omens, merely in consequence of seeing five or six affirmative instances.

(3) To be a fancy of the cave, means, to be the object of a false notion originating in some defect belonging to this or that individual man, resulting from his peculiar idiosyncrasy, or the like. Such is the fancy of those prejudiced persons who imagine that *antiquity* is the only proof of a doctrine's being true, and that all *new* doctrines must be false.

(4). To be a fancy of the market place, means, to be the object of a false notion originating in the mutual verbal intercourse that belongs to ordinary affairs, when that is taken to have force [or meaning] which is merely constituted by the imagination of the vulgar. Thus the Bauddhas hold, that, because there are such terms as "hare's horns," "tortoise's hair." "son of a barren woman," "sky-flower," "the lake of the mirage,"—therefore the *things* also exist.†

(5). To be a fancy of the theatre, means, to be the object of a false notion originating simply in the credulous acceptance of a [pseudo-philosophical] system. Thus the Bauddhas, the Jainas the Yavanas, &c., hold as true various things set forth in their books of doctrine, such as that there is a multiplicity of gods:—that water can be cleared of animals by straining;—and that the heavens are seven.

(6). Since examples of these four [kinds of Fancies], and special des-

* Novum Organum Aph. 39.

† The above is taken as a "glaring instance" of the delusion (alleged by the Pandits to have been once) exercised by language. An instance of the more subtle influence of the delusion is exhibited in the incapacity of perhaps more than ninety men (Europeans—) out of a hundred, to understand,—with the most distant approach to an apprehension of it,—Bishop Berkeley's argument in regard to matter. They exclaim impatiently—"blue! —red!—soft!—hard!—blue *what?*—soft *what?*"—and so forth. The forms of the grammar of the market-place are taken by them for the Ideas of the Divine Mind. "An adjective requires a substantive," says Lindley Murray;—consequently "what we call sensible qualities imply matter," argue those whose range of conception is bounded by the language of the market-place.

criptions of them, and considerations in regard to their divisions, and their mutual differences, have been set forth in Vitthala Sástrí's commented version of Bacon's Aphorisms,—these are to be sought for in that work and are therefore not dwelt upon here.

(7). Now we have to consider by what means we can become certain of that 'pervadedness' (*vyápti*), which consists in the being invariably attended [—as the origination of smoke is invariably attended by the presence of fire —]; and this [certainty] is possible provided the course of Nature be uniform, but not otherwise. If fire were sometimes to burn, and sometimes to cool,—or if Water were to-day to cool, and to-morrow were to burn;—then the investigation of invariable concomitancies, and the consideration of the means of conducting this, would be quite fruitless;—therefore, to suggest that the consideration of the means of ascertaining invariable concomitancies is *not* fruitless we say:—

*Aphorism XIX.*

The course of Nature is uniform.

(1). 'Of Nature,'—*i. e.*, of the world. 'Course,'—*i. e.*, the current of effects and causes. 'Uniform' *i. e.*, of invariable form.

(2). But then [—some one may say—]—the uniformity of the course of Nature is not established by every one's experience,—for no one makes sure that two things, the one of which he has experienced and the other not, or the one of which is past and the other future, must be alike. For example —no one imagines that in whatever month, day, watch, hour, moment, &c., in some particular year, there was rain or the absence of rain,—there will be, in another year, exactly the same succession. Nor does any one expect that the same dream which he has experienced to-day will recur tomorrow or the next day. On the contrary,—if, on any occasion, one beholds the same dream which had been beheld on a previous night, then people become astonished in their minds. Hence as it is the hope of clowns alone that they will be successful on the same-named day as that on which success had been previously met with, so [—it may be argued—] the expectation of regularity and similarity in the course of nature, is in vain, since there is no foundation for it. Nor is the uniformity of the course of Nature established by argument, for it is irregular, inasmuch as we find a straying away [of what a hasty examination had led us to imagine a Sign, from that which we had fancied it to be a sign of]. Thus, some relations are seen to be everywhere the same as they were seen once,—as fire and smoke [—the latter of which is an unmistakeable sign of the former]; but others are exceedingly irregular;—when expected, they do not appear,—when not looked for, they do appear;—for example, a particular night and a particular dream [have no relation such that by means of the one we could determine the other.] Others, again, though their invariable concomitance had been firmly believed, abandoning their previously received relation of concomitancy, are found in conjunction with some other unthought-of property, hitherto unseen [in such connection];—as, for instance, the nature of a swan and whiteness. For that these two should go together [—so as that there should be no swan not white—] was accepted by all the ancients as a thing certain; but when *black* swans were found in the great southern island [Australia], then, from seeing this dissociation [between swan-hood and whiteness], quite recently, this [long received opinion] was abandoned. Thus, then,

since there is no reliance even on a long-received decision of concomitancy, we ought not [says our supposed objector—] to assent to the uniformity of Nature. If any one says this,—there is some truth [in what is said]; but, what we assert is, not that all properties whatsoever are invariably attended by all other properties,—but *some* by *some*; and what we are bound to strive for, is, in the case of properties which really are invariably associated with others, to search out the invariable concomitancy that exists.

(3). It being thus settled that it is necessary to enquire into the method of ascertaining invariable concomitancies,—we find that a perfect result is not attained merely by the method which is employed by people in general. That is to say,—people in general hastily imagine invariable concomitancies from the frequent observation of affirmative instances alone, and do not seek also for negative instances, apprehending that there may be dissociation [somewhere—of things which they have seen frequently associated]. This being so, since they do not see negative instances, because they do not look for them, fancying their own conjecture to be true, if they do meet anywhere with a negative instance, they seek to set it aside by imagining various distinctions.* We intend to explain the way, in which those acquainted with the correct method of Induction, having examined negative instances, determine that there is no invariable concomitancy, or else exclude the suspicion that the concomitancy is not invariable.

(4) But how then,—is the observation of affirmative instances,—the method employed by people in general,—*useless*? To remove this suspicion, we state.—

*Aphorism XX*

Inductive enquiry sets out from affirmative instances.

(1). That is to say,—Inductive enquiry merely begins with, but is not completed by, the observation of affirmative instances. For its completion a very certain and powerful method is indispensably required, the description of which is the subject of the present section.

(2). Now, to make clear what is meant by the assertion that the course of Nature is uniform,—we state:—

*Aphorism XXI.*

The uniformity of the course of Nature is compounded of all the uniformities which belong to single properties.†

(1). The import is this,—that what is called the uniformity of Nature is not some independent thing, but an endless aggregate of properties [or phenomena] which stand to one another in the relation of invariably attended and invariably attending. The concomitancy of particular phenomena is established by the one's being invariably present along with the other, and the other's being invariably absent along with this. By these several concomitancies, belonging to particular phenomena, as if by constituent threads, is made up, as a web, the great whole,—this state of things which we call the course of Nature; and, as we see the uniformity in the several parts, we speak of the whole also as being uniform.

(2). We advert to a distinction among these [uniformities that present themselves in Nature].

* Novum Organum B. I. § 25. † See Mill [in "Reprints" No. III.] p. 53.

*Aphorism XXII.*

Certain of the uniformities which have been determined by investigating on a rightly inductive method, are named Laws of Nature [—or seeds of uniformities], (*niyamabíja*).

(1). That is to say,—that [law or] uniformity which is not a product of other uniformities, but from which other uniformities arise, is to be treated as a *seed of uniformities* [or ultimate Law of Nature]. For example,—(1) the Atmosphere has weight,—(2) pressure on a fluid causes motion in all directions,—and (3) a force, not counteracted by an opposing force, produces motion. Now a uniformity which, resulting from the uniformities just mentioned, appears in the form of another law combining these, is to be treated as a Derivative Law [—not an Ultimate Law of Nature]. Such is the rise of the mercury in the Torricellian tube; for this is merely the result of the triad of uniformities just instanced,—and, by means of thoroughly understanding this instance, it may be understood what cases have been already provided for [—so that they need not be severally elevated into Laws of Nature]. How the mercury rises in the glass-tube is explained in the section on the weight of the atmosphere.

(2). Now we state why, among the various uniformities, we speak of some as Laws of Nature [or the seeds of uniformities].

*Aphorism XXIII.*

Those uniformities alone, which are directly willed by the Ruler of the Universe, are Laws of Nature.

(1). That is to say,—it is an established fact that there is a Ruler of the Universe,—who, seeing that he guides the world, must be Omniscient, Omnipotent, not liable to err and independent:—and such laws as, if admitted as expressions of His will, can explain and account for all the other uniformities that exist in the world, are alone held to be the direct expressions of His will;—because this supposition is the simpler,—whereas it would be cumbrous, and purposeless, and a thing unsupported by evidence, to suppose that His will acts directly everywhere.

(2). But then [some one may object],—if the method of Induction, which you are going to set forth, be the only means of ascertaining invariable concomitancies, then the invariable attendedness of smoke by fire, and the like, would not have been known:—for people are not acquainted with the method which your worship has in view;—and if you admit that there is any *other* method in the world which determines cases of invariable concomitancy, then, since what is to be done can everywhere be thereby effected, what use is there in setting forth a *new* method of ascertaining concomitancies? This doubt we proceed to remove.

*Aphorism XXIV.*

Having taken as examples the concomitancies, relatively to things spontaneously presenting themselves, which concomitancies are involuntarily recognised, the scientific methods are exhibited, which may serve for the discovery of concomitancies in new cases [—where the truth is not so glaringly obvious].

(1). 'Which present themselves,' &c. For no science is needed for learning such uniformities as, that, food nourishes, water drowns, or

quenches thirst, the sun gives light and heat, stones, &c. have a tendency to fall,—and the like,—because, since food, water, the sun, &c., present themselves spontaneously, and since hunger, thirst, cold, &c., naturally assail people,—such concomitancies are easily ascertained alike by child and sage. But where things do not spontaneously present themselves, or, when they have presented themselves, cannot be ascertained, as a matter of course, to stand in the relation of the invariably accompanied and the invariable accompanier, then, in order to effect the great gain of the certainty in regard to the concomitancies of such things, science is called upon to indicate the methods of investigating concomitancies. And if, among men in general, *no* case of invariable concomitancy had ever been determined by any body, then how could a science ever have attempted to set forth a method of seeking for such things? seeing that the knowledge of scientific facts—which consist of what had not been heard of or seen—is based on the knowledge of examples which consist of things that had been agreed upon by all mankind.

(2). Now the setting forth of the *methods* of investigating concomitancies founded on the relation of cause and effect, presupposes an exposition of what is *meant* by the relation of cause and effect;—therefore, to set forth the nature of causation, we remark:—

*Aphorism XXV.*

Every fact which has a beginning has a cause.*

(1). 'Has a cause' By a *cause* we mean exactly that, on the [emergent] existence of which [an event called] the effect is immediately produced. And thus, scientifically, the whole aggregate, in the shape of the collection of things mutually co-operative, is what is to be treated as the cause,—and not, as in ordinary discourse, any of the constituent things severally. Since the effect is not produced on the existence merely of these severally, that which, among the associated things, comes last in order, is recognised as immediately preceding the effect, and is spoken of, in ordinary discourse, as the cause;—but, since, at different times and places, each portion of the aggregate [of the antecedents] may occur last, any one of those may, according to common usage, get the name of the cause. For example,—a stone thrown into water goes to the bottom. Here there are many things which make up the aggregate which is the cause of the stone's going to the bottom. Thus, there are the stone, the water, the throwing into the water, the bottom, the attraction of the earth, the stone's being within the sphere of the earth's attraction, and the immersed stone's being heavier than an equal volume of water. Now, scientifically, the aggregate of all these is properly spoken of as the cause; but if, in ordinary life, it is asked what is the cause of the stone's going to the bottom,—then one person will mention as the cause the first of the circumstances just enumerated—another the second,—and another the third, &c. Nor do we find any fault with this;—only, in scientific discourse, to make it simpler, the whole aggregate only is spoken of as the cause. The absence of counteracting agencies is included in this [aggregate of antecedents], and is not separately a cause.

(2). But then, where, between two things, the relation of prior and se-

* Mill [in "Reprint No. III."] p. 61.

quent is not discerned,—there, the relation of cause and effect [—it may be objected—] cannot be ascertained. For example, in the case of a jar, and its colour, savour, &c. no sequence is observed,—therefore in that case there is a doubt as to the relation of cause and effect. And if, even though they exist simultaneously, the jar be the cause, and the colour, &c., the effect,—then why may it not be the reverse,—that the colour, &c., are the cause, and the jar the effect? This doubt we proceed to clear up, by implication, as follows.

*Aphorism XXVI*

In a case of sequence, antecedence determines which is the cause,—for the effect can never precede the cause;—but in cases of co-existence, let the point for the present remain in doubt.

(1). 'For the present.' At this stage, a criterion for determining which is the cause and which is the effect, in a case of co-existence is not pointed out; but this shall be shown hereafter,—so that there is no harm if the point remain in doubt for the present:—such is the import.

(2). But then, if, in the case of sequence, it is the circumstance of being antecedent or subsequent that determines which is the cause and which is the effect, then, though it be certain that the whole aggregate of things existing in the prior second must be the cause of the whole aggregate of things existing in the following second, yet how are we to discover where the relation of cause and effect exists between the things severally which constitute the aggregate? With reference to this, we state the method of determining individual cases of cause and effect.

*Aphorism XXVII.*

At the commencement of the enquiry we must analyse the aggregate of things which presents itself under the aspect of antecedent and consequent.*

(1). 'Must analyse.'—that is to say, must attend separately to those portions of it, which [under the aspect of antecedent and consequent]constitute this [—viz., the entire aggregate of antecedents and consequents in the world]

(2). But then, will the purpose in hand be effected by a mere *mental* contemplation of the individual phenomena which are the parts of that pair of wholes [—the aggregate of antecedents and the aggregate of consequents]?—To this we reply—Nay.

*Aphorism XXVIII.*

But the root of the determination of this is the separation of the portions of that aggregate [—not in our minds only, but in nature].

(1). 'Separation,'—*i. e.*, leaving out [this or that portion]. For example,—having, at some prior instant, perceived a potter, jar-halves, a wheel, staff, rag, &c.; [or again] a weaver, thread, brush, loom, &c.; [or again] damp fuel, fire, the conjunction of the two, &c.; [or again] a seed, water, earth, the light of the sun, wind, &c.;—some one, at a subsequent instant, perceives a jar, a web, smoke, a sprout, &c.;—then, though he knows for

* See Mill, in "Reprint No. III." p. 83.

certain that the latter aggregate has arisen from the former aggregate, yet he remains doubtful as to which is the cause severally of the jar, the web, &c. Then, for the purpose of determining this, beginning to investigate, he must first reckon up which of the facts were perceived as antecedents, and which of them as consequents. After that, having selected one result, —say a jar—as the one to be effected, he must exclude one thing after another from that aggregate which he had found to have the character of antecedents. In this case, if, when thread, seed, fire, &c., have been excluded, the jar is still found to be produceable, then it is determined that *these* are not causes of the jar.

(2). This separation [of antecedents] may take place in two ways, according as it is at the disposal of man, or only at the disposal of God. The separation is at the disposal of man when, as in the case just instanced, a man can, by his own efforts, make the *experiment*. When, again, it is only at the disposal of God, *observation* only can be made;—*i. e.*, the thing is to be looked at when it occurs,—as in the case of an eclipse, for example. In this case, if, having seen, among the antecedents, the fact of its being —say—*Monday*, a doubt arises whether *this* be the cause, then, since the exclusion of the fact of its being Monday, and the production of an eclipse in the absence of Monday, are in the power of God only, we must make an observation when an eclipse takes place when it is *not* Monday. We have already explained the nature of Observation and Experiment. Now, in the case of Observation and in that of Experiment alike, there is a viewing of this or that phenomenon which we wish to see, but the difference between them is this, that, in viewing a phenomenon which furnishes a case of mere Observation, man is not independent, whereas, in the case of Experiment, he has the things at his disposal.

(3). We proceed to point out a two-fold division of Observation and Experiment, severally, as they are concerned with instances of agreement and instances of difference.

*Aphorism XXIX.*

When we have to determine, among the aggregate of antecedents and the aggregate of consequents, what phenomenon is connected by an invariable law with this or that other one, then, in the first place, the course is (1) to examine instances of agreement, and (2) to examine instances of difference.

(1). Now we describe the Canons according to which the two methods above-mentioned are to be applied in a case which is one of invariable attendedness.

(2). Now the First Canon.

*Aphorism XXX.*

Of the phenomenon the cause of which is under investigation, that circumstance is the cause, in which circumstance alone [—excluding the circumstance of numericalness, &c. which all conceivable instances must have in common—] all the instances agree.

(1). For example, fire in conjunction with damp fuel is the cause of smoke, because all instances of smoke are similar in regard only to their special character of having fire in conjunction with damp fuel.

(2). Now the Second Canon.

*Aphorism XXXI.*

Of the phenomenon under investigation, the cause is that circumstance which exists in only the one of two instances, having every other circumstance in common, in the one of which instances the phenomenon occurs, and not in the other.

(3). For example, mountains, culinary hearths, yards and cowpens that have smoke, and those that have not, are similar in their possessing the nature of mountain, culinary hearth, yard and cowpen, but not in having fire in conjunction with damp fuel. Hence the characteristic of instances of smoke, being in the form of fire in conjunction with damp fuel, is the cause of smoke.

(4). Now the Third Canon.

*Aphorism XXXII.*

If a phenomenon varies in any manner whenever another phenomenon varies in like manner, then it may be understood that the two phenomena stand in the relation of cause and effect.

(1). For example, the tide of the ocean is higher or lower according to the greater or less proximity of the moon. Therefore the proximity of the moon is the cause of the tide.

(2). The application of these rules to [the investigation of] a phenomenon is now to be shown. For this purpose the method of their employment is pointed out in the case of the inquiry into the nature and cause of Dew, which were mentioned as proved in the commentary on the 17th Aphorism [of this Book].* Before the investigation of a phenomenon that is to be inquired into we must determine precisely what is meant by the name thereof. Hence [in the case of Dew] we must separate Dew from rain, and the moisture of fogs, and limit the application of the term to what is really meant by it, which is, the spontaneous appearance of moisture on substances exposed in the air where no rain is falling. The subject of the inquiry being thus fixed, we remark,† in accordance with Aph. XXX, that the investigation is to be conducted agreeably to the First Canon.

*Aphorism XXXIII.*

When the cause of a nature is given for investigation, we must first enumerate all the [known] instances which agree in the same nature, although [the subject-matter be] considerably diversified.‡

(1). '*Which agree,*' &c. Now the moisture which bedews a cold metal or stone when we breathe upon it, that which appears on a glass of water fresh from the well in hot weather; and that which is seen on the inside of windows when sudden rain or hail chills the external air—all these instances of dew always agree in one point, the coldness [of the object dewed] in comparison with the air in contact with it. But [—some one may say] this does not hold good in the case of nocturnal dew. For here there is nothing that can produce coldness in the object dewed in comparison with the surrounding air. [Certainly not], for what is to produce it?—one would

* See Mill [—in Reprint No. III. p. 112]. † Ibid. p. 112.
‡ Novum Organum, B. II. § 11.

at first be inclined to say. But experiment proves that objects on which nocturnal dew is deposited *are* colder than the air, and the experiment is easily made: we have only to lay a thermometer in contact with the dewed substance, and hang one in the air at a little distance above it [out of reach of its influence]. This experiment has been frequently made by inquirers, and the above-mentioned character has been invariably perceived, and it has thus been proved that dew is always accompanied by greater coldness [in the object dewed] than that of the surrounding air.

(2). Here then the fact of this invariable connection having been established, the doubt remains whether such coldness is the cause of dew, or dew the cause of such coldness, or whether they are both effects of something else. The solution of this cannot be effected by the observation of a thousand instances of agreement,—we must call in a more potent method. Those who are inclined to the Anticipation of Nature, from perceiving coldness wherever there is dew, fancy that the coldness is the effect of dew. We now describe, in accordance with the second Canon mentioned in Aph. XXXI, the method, in the shape of the examination of negative cases, by which, in the subject before us, ascertainment is to be made by inquirers who follow the Interpretation of Nature, being in doubt as to the truth from not perceiving a decisive cause.

*Aphorism XXXIV.*

We must next enumerate *Instances* which do not admit of the given nature; and the want of the given nature must be inquired into more particularly in objects which very closely resemble those others in which it is present and manifest.*

(1). '*Which very closely resemble.*' &c. Now no dew is produced on the surface of *polished metals* placed in the open air, but it *is* very copiously on pieces of glass similarly exposed; and in some cases the under side of a horizontal plate of glass is also dewed. But these negative and affirmative instances do not very closely resemble each other, for the differences between glass and polished metals are manifold, metals being malleable, opaque, and comparatively heavy, and glass on the contrary brittle, transparent, and comparatively light. So the Second Canon cannot be made use of here, because it can be applied only in the case of those affirmative and negative instances which agree in all their circumstances except *one*, and the only thing we can as yet be sure of is that the cause of dew is *among the circumstances* by which the affirmative instance is distinguished from the negative.

(2). But if we could be sure that glass, and the various other substances on which dew is deposited, have only *one* quality in common, which is absent from polished metals and the other substances on which dew is *not* deposited, the result of the second canon would be gained, and hence it would be proved that that quality [of the substances] is the cause of dew. This accordingly suggests the path of inquiry which is next to be pursued.

(3). In the cases of polished metals and polished glass, the absence and presence of dew show evidently that the *substance* had much to do with the phenomenon, and not the polished surface; therefore let polished surfaces of various kinds be exposed in the air. This done, a *scale of intensity* be-

* Novum Organum B. II. §. 12.

comes obvious. Those polished substances are found to be most strongly dewed which conduct heat worst, while those which conduct well resist dew most effectually. Here the Second Canon cannot be made use of, since all substances conduct heat in some degree. Therefore the Third Canon is to be employed, and, in accordance with Aph. XXXII, we remark :—

*Aphorism* XXXV.

We must enumerate the instances in which that nature, which is the object of our inquiries, is present in a greater or less degree, either in the same object or in different objects. For, since the effect is dependent upon the cause, it follows that that is not the cause, which does not uniformly diminish and increase with the given effect.*

(1). *'It follows'*. &c. The conclusion obtained is, that, *caeteris paribus*, the deposition of dew is in some proportion to the power which the body possesses of resisting the passage of heat, and it is plain that that power, from its favouring the deposition of dew, must be among the causes which assist in producing it.

(2). But if we expose rough surfaces instead of polished, we sometimes find this law interfered with. Thus roughened iron, especially if painted over or blacked, soon becomes dewed; the kind of *surface*, therefore, has a great influence.

(3). Expose, then, in accordance with the second canon, the *same* material in very diversified states as to surface, and another scale of intensity becomes at once apparent; those *surfaces* with *part with their heat* most readily by radiation, are found to contract dew most copiously. Here, again, the Second Canon cannot avail us, since all substances radiate heat in some degree, but the Third Canon is to be made use of, and the conclusion [obtained by this new application of the method] is, that *caeteris paribus* the deposition of dew is also in some proportion to the power of radiating heat, and that the quality of doing this abundantly is, like the power of resisting the passage of heat, another of the causes which promote the deposition of dew upon the substance.

(4). Again, as *substance* and *surface* promote the deposition of dew, it is possible that *texture* may do so also: and here, again, we are presented, on trial made in the manner before described, with a third scale of intensity, pointing out substances of a close, firm texture, such as stones, metals, &c., as unfavourable, but those of a loose one, as cloth, wool, [velvet, eider-down, cotton,] &c., as eminently favourable to the contraction of dew. But here, as the Second Canon cannot be employed, because, since the texture of no substance is absolutely loose, we cannot find a negative instance, the Third Canon is had recourse to, and by this it is proved that, like the power of resisting the passage of heat, and the power of radiating it readily, looseness of texture also, naturally promotes the deposition of dew.

(5). But this cause, looseness of texture, resolves itself into the first, viz., the quality of resisting the passage of heat: for substances of loose texture are precisely those which are best adapted for clothing; for, as they remain warm within while their outer surfaces are very cold, they impede the passage of heat [from the body] into the external air; and so this third induction [of fresh instances] is simply corroborative of the first

* Novum Organum B. II. § 13.

induction. It thus appears that wherever dew is deposited there is either the quality of readily radiating heat, or of resisting its passage strongly, by virtue of which the substances tend to lose heat from the surface more rapidly than it can be restored from within. Wherever, on the contrary, no dew is formed, neither of these same properties is present.

(6). We might now consider the question, upon what the deposition of dew depends, to be completely solved, if we could be quite sure that the substances on which dew is produced differ from those on which it is not, in *nothing* but in the property of losing heat from the surface faster than it is supplied from within.

(7). Now, although one not omniscient never can have that complete certainty, it may, at all events, be affirmed that even if there be any other quality hitherto unseen and unheard of which is present in all the substances which contract dew, and absent in those which do not, this other property must be one which is present or absent exactly where the property of being a better radiator than conductor is present or absent; so that the property of being a better radiator than conductor, if not itself the cause, always accompanies the cause, and, in practice, no error will be committed treating it as if it were really such. So much for this incidental matter; we now revert to the inquiry.

(8). We had ascertained that, in every instance where dew is formed, there is actual coldness of the surface below the temperature of the surrounding air; but there remained the doubt whether this coldness was the cause of dew, or its effect. If, in accordance with the practice of the generality of mankind, it be asserted that it is the effect, we reply that such coldness is the cause of dew, and the cause of that coldness is the property of being a better radiator than conductor of heat, for such coldness is produced by that very natural property which the [dewed] substances possess of radiating heat quicker than they conduct it, when exposed to the air by night. But if the dew be said to be the *cause* of the coldness, why is not that effect produced in all other substances, and not solely in those in which it is produced by the cause pointed out, *viz.* by their own natural laws? The supposition, therefore, that dew is the cause of the coldness, is repelled.

(9). But there were only three suppositions mentioned above;—that dew is the cause of the coldness; that both are caused by some third circumstance; or that coldness is the cause of the dew. The first is refuted. The second is inapplicable, the cause of such coldness being a known cause; and when we *see* a cause it is improper to imagine an unseen one. The third supposition, that the coldness is the cause of the dew, may, therefore, be considered as completely made out.

(10). Thus we have described the application of the several rules in various *Instances* that are to be considered in inductive investigation. Now the question may arise, whether all instances be of equal value for the ascertainment of truth, or whether they be of greater and less importance, so that some may have the prerogative* of being reckoned first in a number of instances, whilst others are considered afterwards. In regard to this, we remark, affirmatively of the latter alternative, that:—

* Novum Organum B. II. § 21.

*Aphorism XXXVI.*

There is much difference in the value of instances.

(1). Some instances show the thing sought for in the highest degree, some in the lowest; some exhibit it uncombined, in others it appears confused with a variety of circumstances. With reference to such differences, Bacon has enumerated twenty-seven species of instances which especially claim attention. The detailed account of these is to be seen in Viṭṭhala Sástrí's version of Bacon:—we can here notice only a few of the more important.

(2). *'Solitary instances'* are those "which exhibit the nature inquired after in such subjects as have nothing in common with others besides the very nature; or, again, those that exhibit the nature inquired after in such subjects as are every way similar to others, excepting in that very nature. It is manifest that such instances as these will shorten the inquiry, and promote and hasten the exclusion."* Thus if the cause of colour be inquired into, solitary instances are found in crystals, prisms, drops of dew, &c., which occasionally exhibit colour, and yet have little or nothing in common with the stones, flowers, and metals which possess colour permanently, except the colour itself. Hence it may be concluded that colour is nothing else than a modification of the rays of light, produced, in the case of crystal &c., by different degrees of incidence, and, in the case of flowers &c., by the texture or constitution of the surfaces of the bodies which reflect the light. Again, in the same inquiry, the different-coloured leaves of variegated flowers [of the same species] are solitary instances, for these agree in almost every respect *except* in colour. Whence it is easily collected that colour, which is a particular modification of the rays of light, does not greatly depend upon the intrinsic nature of the coloured body, but is owing to a variety in the texture of the parts of the surface.

(3). *'Travelling instances'* are those wherein the nature inquired after travels or advances, to generation, when it was not before in being; or, on the contrary, to destruction, when it was in being before.† Instances of this kind accelerate the business of exclusion, because the cause must necessarily be something introduced or abolished, in the progress of this transmigration. Suppose the thing inquired into were the cause of whiteness,—a 'travelling instance' is found in glass, which is colourless when whole, but becomes white by pounding. In the same way water when at rest is colourless, but appears white when beaten into foam.

(4). *'Glaring instances'* are such as show some nature in the highest degree of its power, when it is freed from impediments which usually counteract it.‡ Thus, if the weight of the air be inquired into, the Torricellian tube affords a 'glaring instance,' because here the circumstance which usually conceals the weight of the atmosphere, namely, the pressure of it in all directions, being entirely removed, the effect of the weight of the atmosphere is clearly seen in sustaining the column of mercury in the tube.

(5). Now if there appear at first several causes of a result, all of them equally good, and the doubt arise, which of them is really the cause, those instances which decide that this or that only is in reality the cause, are called *'crucial instances.'* They are so named from the crosses set up where two

* Novum Organum B. II. § 22. † Novum Organum, B. II. § 23. ‡ Ibid. § 24.

roads meet, to point out their different directions.* Thus, when the power of producing some one result appears equally in several things, and it is doubted which of these is really the cause, we must seek for an instance in which some property that is observed is explicable by *one* of these causes and not by any of the others. And such are 'crucial instances,' as in the following example which occurs in Chemistry. When a mass of tin or lead is calcined in the fire, although the adhesion of ashes, coal, &c., be carefully prevented, the absolute weight of the mass is always found to be increased. It was long before the cause of this phenomenon was understood. For the result might be brought about either by the addition of some unknown heavy substance, or by the escape of some light substance which was the cause of the former comparative lightness. The ancient chemists adopted the latter opinion, and this light substance they called phlogiston. They held that this, by its escape, rendered the metal heavier, and they therefore imagined it to be endued with absolute levity. But no certain knowledge of the truth was gained by this, as experiment was not had recourse to; hence a certain chemist [Lavoisier] perceiving that a crucial instance was necessary, made the following experiment. Having included a quantity of tin in a glass vessel, hermetically sealed, and having weighed it together with its contents, he applied the necessary heat; and when the calcination of the tin was finished, he weighed the vessel containing the calcined metal; and, finding the weight of the whole precisely the same as before, he thus proved that no heavy substance had entered in, and no light one had escaped. Again, when he cooled the vessel, and made a hole in it, he observed that the air rushed in with a noise; he then weighed the apparatus again, and found that its weight was increased by ten grains, so that ten grains of air had entered into the vesse when it was opened. The calx was next taken out, and weighed separatelyl and it was found to have become heavier than the tin by ten grains precisely., It was thus proved that the ten grains of air which had disappeared, and which had made way for the ten grains that rushed into the vessel, had combined with the metal at the time of calcination. And thus, by the observation of this instance, the imaginary substance phlogiston, endued with absolute levity, was exploded, and the real cause of the phenomenon established, namely, that a portion of the common air combines with a metal in the process of calcination, and the weight of the calx is increased by the weight of that air. On this subject we have now said enough.

(6). Having completed what we intended to say here in regard to the forming an 'inductive generalization' (*anumána*), we proceed to consider the application, to ratiocinative purposes, of the 'instrument of right knowledge' (*pramáṇa*) thus placed at our disposal.

## Section III.—Of the Deductive Process.

### *Aphorism XXXVII.*

An induction (*anumána*) is the instrument of an inference.

(1). An inference† is knowledge that results from syllogizing (*pará-*

* Novum Organum, B. II. § 36.

† This section, and part of the next one, we adopt from the *Tarka-sangraha*. See our English version, p. 40.

*marśa*). Syllogizing is the taking cognizance that the subject (*paksha*) possesses what is constantly accompanied [by something else which is thus seen to belong to the subject]. For example,—the taking cognizance that 'This hill has smoke—which is constantly accompanied [at the point where it originates,] by fire'—is [an instance of] syllogizing [—*i. e.*, of apprehending, in connection, an induction and an observation]. The knowledge resulting therefrom, *viz.*, that 'The hill has fire [somewhere about it],' is an inference. 'The being constantly accompanied' (*vyápti*) is such an invariableness of association as this—that wherever there is smoke there is fire. By the 'subject's *possession*' [of something that is constantly accompanied], we mean the fact that there exists—in a mountain for instance—that which is constantly accompanied [by something else].

(2). An induction may be regarded under two aspects, with reference to its employment,—as we proceed to remark.

*Aphorism XXXVIII.*

An induction is of two kinds, (1) for oneself, and (2) for another.

(1). First, then, we define an induction employed for oneself.

*Aphorism XXXIX.*

That which is for oneself is the cause of a conclusion of one's own.

(1). For example, having repeatedly and personally observed, in the case of culinary hearths and the like, that where there is smoke there is fire, having gathered the invariable attendedness [of smoke by fire], having gone near a mountain, and being doubtful as to whether there is fire in it, having seen smoke on the mountain, a man* recollects the invariable attendedness, *viz.*, 'where there is smoke there is fire.' Thereupon the knowledge arises that 'this mountain has smoke, which is constantly accompanied by fire.' This is called the 'pondering of a sign' (*linga-parámarśa.*) Thence results the knowledge that 'the mountain is fiery,' which is the conclusion (*anumiti*). Such is an induction [employed in a process of inference] for oneself.

(2). Next we have to give an account of an induction employed for the sake of another; and since much has to be said on this subject, a new section is commenced. In the first place an '*Induction for another*' is explained.

## Section IV.—On the Process of Demonstration, or Rhetoric.*

*Aphorism XL.*

After having, for oneself, inferred fire from smoke, when one makes use of a distributive form of expression, with a view to the information of another, then there is an induction [employed in a process of inference] for the sake of another.

(1). For example:—(1) The mountain has fire in it; (2) because it

* "Reasoning may be considered as applicable to two purposes * * * * * * * * the *ascertainment* of the truth by investigation, and the *establishment* of it to the satisfaction of *another*:—* * * * * * the latter belongs to the province of Rhetoric":—[Whately, in 'Reprint No. 8,' p. 3].

has smoke; (3) whatever has smoke has fire, as a culinary hearth; (4) and so this has; (5) therefore it is as aforesaid. By this [exposition], in consequence of the sign [or token] here rendered, the other also admits that there is fire. The five members in the foregoing exposition are severally named (1) the proposition (*pratijná*), (2) the reason (*hetu*), (3) the example (*udáharaṇa*), (4) the application (*upanaya*), (5) the conclusion (*nigamana*). 'The mountain is fiery' is the proposition, 'because of its being smoky' is the reason; 'whatever is smoky is fiery' is [the general proposition or principle founded on such instances as] the example [of culinary hearths and the like]; 'and so this [mountain] is,' is the [syllogistical] application; 'therefore it [the mountain] is fiery' is the conclusion.

(2). It is not indispensable that the rhetorical exposition of an argument should consist, as in the foregoing example, of *five* members,—because, as is remarked in the *Vedánta paribháshá*, "The members are *three*, in the shape of the proposition the reason and the example, or in the shape of the example the application and the conclusion;—because, since the general principle and its application to the particular case can be exhibited by *three* members, the two additional members are needless." Nor is it compulsory that everywhere the same order should be observed in our rhetorical exposition. In the rhetorical section of the *Nyáya* we are directed to begin by stating the proposition to be proved. In addressing a candid enquirer after truth, this is the best and simplest mode of commencement. An audience, however, does not always consist of such persons. A prejudiced person, on hearing a proposition which is opposed to his prejudices, is apt to shut his ears and refuse to hear the argument in support of it. In dealing with such persons, we must be guided by this consideration. In the Grecian republics the art of persuasive speaking was a very important one; because the power of the state, being in the hands of the people, was in reality wielded by the speaker who could persuade the assembled people to adopt his views. The inducement to the cultivation of the methods of persuasion being so great, the art of rhetoric attained, in Greece, a degree of perfection which it never attained elsewhere. Observing the success of the great orators, Aristotle reflected that if success in any matter has been once attained, it must be attainable again provided the same means be employed. Having carefully considered the matter, he wrote a treatise, which forms the ground-work of the best treatises on the subject now current in Europe. Of the results arrived at we shall given a brief statement.

*Aphorism XLI.*

The enquiry embraces the four sections of (1) Propositions, (2) Conviction, (3) Persuasion, and (4) Style.

(1). '*Propositions.*' Here it is to be observed that although it may not be always advisable to set out by stating the proposition to be proved, yet it is always most important that the speaker, or writer, should begin by laying it down distinctly in his own mind. This rule is neglected by those who place before themselves a *Term* instead of a *proposition*, and imagine that because they are treating of *one thing*, they are discussing one *question*. For instance, one may be *treating of gold*, while discussing all or any of these questions: "what is the weight of gold?" "what is its value?" "whence is it obtained?"—"how far is it malleable?" &c.; but if these questions were confusedly blended together, or if all of them were treated

of within a short compass, the most just remarks and forcible arguments would lose their interest and their utility, in so perplexed a composition.

(2). [Having remarked thus much in regard to Propositions,] we proceed to divide Arguments.

*Aphorism XLII.*

An argument is of two sorts, inasmuch as it may be a cause or effect, or neither.

(1). Where the argument is a cause or effect, it enables us to argue (1) from cause to effect, or (2) from effect to cause. Where the relation of causation is not involved, the argument consists in the 'perception of homogeneousness' (*sámányato-drishṭa.**) For example,—(1) from the gathering of clouds we anticipate rain,—(2) from the swelling of a river we infer that rain has fallen,—(3) from the blossoming of a mango-tree we infer that other mango-trees are blossoming.

(2). Now, when we are endeavouring to convince some one, he may probably bring forward Objections; and since, if we ourselves are right, these objections must be wrong, it is necessary to consider what sort of wrong arguments, or fallacies,† can be brought forward. These 'semblances of a reason' (*hetwábhása*) may be enumerated as follows:—

*Aphorism XLIII.*

Five that present the semblance of a reason are (1) that which goes astray, (2) the reverse [of what it ought to be], (3) that which is outweighed, (4) the unreal, and (5) the debarred.

(1). That [alleged reason] which goes astray is that which presents itself in that in which there is the *absence* of what is to be proved. For example, —'The mountain must be fiery, because it is cognizable:'—[here the alleged reason would be liable to this objection,] because cognizability belongs [equally] to a lake, which has *no* fire in it.

(2). That [alleged reason] which is the reverse [of what it ought to be], is that which is constantly accompanied by the *absence* of what is to be proved. For example,—'This man is praiseworthy, because he is wicked.'

(3). That [alleged reason] which is outweighed, is that along with which there exists another reason which fully establishes the *non* existence of what is to be proved. For example,—'The mountain is not fiery, because there is water in it, as in a lake,'—to which it may be replied that the mountain *is* fiery, because it is smoking, like a culinary hearth.

(4). An 'unreal' reason is that which is not true. For example— 'Sound is a quality, because it is visible:'—now sound is *not* visible, but only audible.

(5). That [alleged reason] is 'debarred,' where the absence of what it seeks to prove is established for certain by another [and more potent kind of] proof. For example,—'Fire is cold, because it is a substance':—here

* See Nyáya Aphorisms, B. I. § 5, and Lecture on the Sánkhya, § 101.

† In his "Rhetoric" (see 'Reprint' No. 8, p. 92) Archbishop Whately says—"This is the proper place for a treatise on Fallacies, but as this has been inserted in the ELEMENTS OF LOGIC, I have only to refer the reader to it." In the *Nyáya*, the order of which we are now following, the account of the Fallacies comes under the Rhetorical heading, as Whately says it ought. See *Tarka-sangraha*, 2nd Ed. p. 52.

coldness is sought to be established; and its absence, *viz.*, warmth, is apprehended by the sense of touch :—hence the argument is debarred.

(6). When we are not dealing with a properly educated person, it will frequently be found the most convenient method to bring forward another argument with the same defect, in which an absurd conclusion may be introduced as drawn from true premises. For example, if it were argued that Devadatta is a good man, because all good men are charitable, and Devadatta is so: we might illustrate the inconclusiveness of the reasoning by bringing forward the parallel argument that Devadatta is a good man, because all good men are mortal, and so too Devadatta is.

(7). It is no uncommon manœuvre of a dexterous sophist, when there is some argument which he cannot directly defeat, to assent with seeming cordiality, but with some qualification, which, though seemingly unimportant, shall entirely nullify its force. This has been compared to the trick of the pilgrim in the tale, who "took the liberty to boil his pease." The story is as follows :—Two profligates to obtain remission of their sins, in accordance with the decree of a holy man, having filled their shoes with pease, set out on a pilgrimage. After proceeding a few miles, one of them, much distressed by the pain in his feet, and surprised at the apparent indifference of his companion in suffering, enquired whether the pease did not hurt him. The other smiling replied, "No—for I took the liberty to boil my pease before setting out"

(8). Having treated of Conviction, we have next to speak of *Persuasion.* In Persuasion, as distinguished from Conviction, we seek not merely to convey knowledge but to influence the *Will.** Here two considerations may have to be kept in view. We may have to show that the object proposed is a desirable one, and we may have to show that the course suggested will lead to its attainment. The suitableness of the means must be established by argument; but, in order to excite men to adopt those means, we must represent the end as sufficiently desirable. It will frequently happen that the one or the other of these purposes will have been already accomplished, so that the other shall be the only one that it is requisite to insist on. That is to say :—sometimes the hearers will be sufficiently intent on the pursuit of the end, [as in the case of wealth], and will be in doubt only as to the means of attaining it; and sometimes, again, they will have no doubt regarding the means, but will be not sufficiently ardent with respect to the proposed end, [as in the case of virtue].

(9). Having treated of Conviction and Persuasion, we have next to speak of *Style.* The three requisites of Style, as the author of the *Kávya Prakáśa* tells us, are Perspicuity, Energy, and Elegance. Of the three, the first requisite is Perspicuity; since language not intelligible, or not clearly and readily intelligible, fails, in the same proportion, of the purpose for which language is employed. Perspicuity is defined in the *Kávya Prakáśa* as a quality in virtue of which a discourse penetrates the mind as readily as fire enters dry fuel, or as water penetrates clean cloth, a quality appropriate in every species of composition.

(10). The next quality of style to be noticed is Energy, which is defined in the *Kávya Prakáśa* as the cause of lively mental excitement. This (—as is likewise the case in respect of Perspicuity,) must depend on three things; 1st, on the *Choice* of words, 2nd, on their *Number*, and 3rd, on their *Ar-*

* Whately, Rhetoric, in "Reprints" No. 8. p. 105.

*rangement.* With respect to the choice of words—it is convenient to regard words as being employed in two ways,—properly, and figuratively. Of "Proper" terms, with a view to energy, we should always prefer those words which are the least *general.* The impression produced on the mind by a singular term, may be compared to the distinct view taken in, by the eye, of any object [suppose of Nárada, after his gradual descent as described at the opening of the poem of *Mágha*] near at hand, in a clear light, which enables us to distinguish the features of the individual, in a fainter light, or rather further off, we merely perceive that the object is a *man;* this corresponds with the idea conveyed by the name of the *species*, yet further off, or in a still feebler light, we can distinguish merely some *living object;* and at length, merely *some object.* As each of these views conveys a *correct* impression to the mind, though each, successively, is less *vivid;* so, in language, a general term may be as clearly *understood* as a specific or a singular term, but will convey a much less *forcible* impression to the hearer's mind. A form of expression which conduces much to energy, is the Metaphor. From its conciseness, the Metaphor is more energetic than the Simile, which differs from the Metaphor in this, that it fully states the resemblance which in the other is implied. There is more energy in the expression "That lion Devadatta"—than in the expression "That Devadatta who is like a lion." The employment of the *Interrogative* form will often prove serviceable with a view to Energy. It calls the hearer's attention more forcibly to some important point; and it often carries with it an air of triumphant defiance of an opponent to refute the argument if he can. For example, if we say, "*Who* ever saw or heard of whiteness in a crow, truth in a gambler, courage in a eunuch, right thought in a drunkard, mercy in a serpent, chastity in woman,—or of a king that was a *friend?*"—though the sense is the same as if we had simply asserted that no one had ever seen such, yet the form of expression is more energetic.

(11). The last quality of Style to be noticed is Elegance. This quality is always desirable where it does not seriously interfere with *Energy.*

(12). Now, intending to commence a new section, we remark, that the fallacies mentioned in this Rhetorical section imply a difference of opinion between the proponent and the opponent in regard to the validity either of the alleged reason or of the induction (*anumána*) applicable to the case. For example, if any one argues that 'Sound is a quality, because it is *visible*,' or that 'This must smoke, because it is *fiery*,'—and another person denies the validity of the reasoning, it is because the one assumes and the other denies that sound *is* visible; or, again, because the one assumes, as an induction, that "All that is fiery must smoke," and the other—[having an eye to the ignited iron-ball which does not smoke—] denies the soundness of the induction. But often, where there is no difference of opinion as to the premises, there may yet be a difference of opinion as to what conclusions legitimately flow from those premises. Let us suppose a preceptor and pupil, who are entirely agreed as to the principles (*siddhánta*) which are therefore nowhere liable to be called in question during their conversation,—still, the pupil may err in drawing his conclusions from the principles, and the preceptor must set him right where he goes wrong. In the following section, therefore, *premises* are never to be challenged,—the introduction of challengeable premises into the section following being debarred by the very condition on which the section founds itself,—*viz.*, the possibility that there may be two persons entirely agreeing in regard to principles, but differing

in regard to results. Discussion, on such terms, is known as 'Conversation' (*Váda*) in the *Nyáya*. As the disputants in question nowhere disagree in regard to the *matter* of the dispute, their disagreement must be one capable of being cleared up by attention to the *form* of the expressions,—and therefore we give to the following section the title of FORMAL LOGIC.

### SECTION V.—OF FORMAL LOGIC.

(13). Now, commencing the section on Discussion [—*váda, i. e.*, the examination of the validity of an argument, where there is no question as to the truth of the premises—], we state the subject-matter thereof.

*Aphorism XLIV*

The cognizing the nature of the subject and predicate [—*i. e.* Simple Apprehension]; the cognizing of the relation between those two [—*i. e.*, Judgment—]; and inferring, [are the three mental operations, or states, with which we are more immediately concerned in the present section].

(1). Of these [three mental operations] the first [*viz.* Simple Apprehension] is that operation whereby there arrives the knowledge either of the thing spoken of, or of what is asserted in regard to it. The second [*viz.* Judgment] is that operation whereby the relation of these two, when they have arrived [and are present to the mind], is cognized. The third [*viz.* Inferring] is that operation whereby, after cognizing the import of the general principle, and its application to a particular case, the inferential result is cognized, in the shape of "Therefore so is *this*." Our speaking [in English] of both the act and its result under the same name [—*e. g.*, Judgment, and a judgment—], is allowable,—just as is the denominating of the Sight &c., and of the cognitions resulting therefrom, by the term *pratyaksha* [—which stands alike for a sense and for sense-perception].

(2). For producing this triad of operations in the mind of another person, an expression, in the shape of a Syllogism (*nyáya*), is employed. That portion thereof, from the hearing of which there is produced an act of the mind of the hearer conducive to the apprehension of either the thing spoken of, or of what is predicated of it, is called [severally] the portion of [the expression, which portion, being a *term*, denotes] the Subject or the Predicate—(*uddeśya bhága* and *vidheya-bhága**). That by which there is produced an act of the mind of the hearer conducive to the cognition of the relation between these two, is called a *proposition* (—*nyáyávayava*,—literally, "member of a syllogism"). And that by which there is produced the act of the mind of the hearer called *reasoning* is the [entire argument or] *syllogism* (*nyáya*). For example—

"Every thing smoking is fiery;
The mountain is smoking;
Therefore it is fiery:"—

* It is to be borne in mind that in the Nyáya section of *swárthánumána*, the *vidheya* in such a proposition as "The mountain is smoking." is *smoke*; while, in the section of *parárthánumána*, it is held (—e. g., by the author of the *Anumána-chintámani-dídhiti*,—), to be not the smoke, but *smoking*. As this latter view accords with European usage, the terms *vidheya, sádhya*, &c., are so employed in this section. The distinction of usage referred to may be seen in pages 122 and 128 of the *Dídhiti*,—(*Calcutta edition of Samvat* 1905).

is a syllogism. Here the Subject and Predicate of the first sentence are "smoking" and "fiery" Of the second sentence the Subject is "the mountain," and "smoking" is the Predicate. By means of those [words] the meaning intended by both [Subjects and Predicates] having been apprehended, the relation of the two, in each of the sentences, [*viz.*, the affirmative relation,—] is cognized by means of the word "*is*," which is understood [—in Sanskrit, and not usually expressed as it is in English†]. In the third sentence, through the force of the expression "*therefore*", by the syllogism—consisting of the whole of the three sentences—there is produced the [knowledge called a] Conclusion, [which may be described as being] in the shape of some particular knowledge resulting from the knowledge of a Reason.

(3). Now *Terms* are liable to the fault of *indistinctness*, *Propositions* to that of being *false*, and *Arguments* to that of being *inconclusive*. In Formal Logic, of which we are now treating, the main thing to be expounded is, by what methods faultiness in an Argument, viz., *inconclusiveness*, may be entirely guarded against; and incidentally we shall treat of the guarding against defects in *terms* and *propositions*, but only so far as this can be done by the *proper use of language*.

(4). Therefore there is derivable, from this study, skill in the employment of language suitable for the establishment of conclusions, and skill in distinguishing a valid argument from that which is spurious. But he only can rightly estimate the importance of this study who knows how far men's thoughts are influenced by expressions, and who considers how many errors, perplexities, and troubles, are occasioned by a faulty use of language

(5). In reference to the defects to which *terms*, *propositions* and *arguments* are liable, there are two distinctions. 1st,—an expression the meaning of which is *indistinctly* apprehended, does not thereby cease to be a Term; nor does that which is *false* cease therefore to be a Proposition; but that from which the conclusion does not result, is *not really* an Argument at all;—such is one distinction. 2dly, no rules are possible such that, by attending to them, Terms should be everywhere clearly understood, and the truth or falsity of Propositions be ascertained. But rules *are* possible, by attending to which we can ascertain that what has this or that form is a valid argument, and that that which has this or that form is *no* argument:—such is the other distinction. And thus, in the present case, rules are to be set forth, by attention to which rules, we may with certainty determine what is *really* a Term, really a Proposition, and really an Argument.

(6). Of a Syllogism there are three Members, made up of the portions which express the Subject and the Predicate And these [Members or Propositions] are severally of two sorts, viz., *affirmative* and *negative*. Such propositions as "The mountain is fiery," are of the first sort:—those like "The lake is *not* fiery," are of the second sort. And here, in both cases, the verb "*is*" [—which is not customarily expressed in a Sanskrit proposi-

† Thus the Sanskrit avoids the danger of having the Logical Copula mistaken for an asserter of *existence*. That the Hindú sages was not unaware of this liability in the verb "to be," is shown (—see p. 41 of No. III. of our "REPRINTS FOR THE PANDITS"—) by the practice of commentators, when a verb that might imply Existence is used in the text as the copula, to warn the reader that "The verb does not here imply Existence, but is employed for the sake of knowledge:"—

विदिरयं ज्ञानार्थो नतु सत्ताभिधायो ॥

tion—] is to be understood; and this, since it is this which makes a Proposition, is the only verb recognised in Formal Logic; and not any other, such as "cooks," "goes," &c., since each of these involves the verb "*is*;" —inasmuch as "He cooks," or the like, means "He *is* cooking [—or is in the habit of cooking—]," or the like. And this word "*is*" is employed with the intention of notifying the relation of the Predicate in question, and not with the intention of predicating *existence*;—for, when we say "A hare's horn, a man's horn, tortoise's hair, the son of the barren woman, and the lotuses of the sky, are fictions," we predicate the *fictitiousness*, not the *existence*, of the hare's horn, and the rest.

(7). A Term [—a Subject or Predicate—], as it may consist of a single word, so may it also consist of a combination of words. For example,—"Maitra, who, for twelve years, studied all the Institutes, under Devadatta, in Benares,—is instructing many disciples." In regard to this, we have an aphorism.

*Aphorism XLV.*

Words are either "dependent" [—*syncategorematic*—] or "independent" [—*categorematic*—]. The "dependent" are those which cannot, without another word, themselves serve as either a Subject or a Predicate.

(1). Since adverbs—as "merrily," "difficultly," and nouns not in the nominative case, as "of all," cannot form a Term without some other word, —as "sporting," "accessible," "Lord," &c. [—"sporting merrily," "difficultly accessible," "the Lord of all,"—] these are *syncategorematic* words. But *categorematic* words as "Chaitra," "Maitra," "jar," "web," "white," "black," &c., are competent to stand themselves as one or other of the Terms.

(2). Now we have to consider the subdivision of *categorematic* words; and, 1st, they are of two sorts,—*common* which denote many individuals, as "man," "river," "mountain," &c.; and *singular*, which denote only a single individual, as "Chaitra," "the Ganges," "the Himálaya," "this tree," &c.

(3). Again they are of two sorts,—*concrete*, as "jar," "white," "Dittha," &c.; and *abstract*, as "colour," "taste," "the nature of a jar," "whiteness." &c.

(4). Again, moreover, they are of two sorts,—*connotative* [—which imply in their signification some attribute of the object denoted—], as "God," "the Himálaya," [or "abode of snows"], "jar," "web," &c.; and *non-connotative*, as "Chaitra," "Dittha," "whiteness," &c.

(5). And again they are two-fold,—*positive*, as "heavy," "hot," "jar," "web," &c.; and *negative*, as "light," [i e., "not heavy"], "cold," [i. e., "not hot"], "not a jar," "not a web," &c.

(6). Yet again they are two fold,—*relative*, as "father," "mother," "brother," "master," "servant," &c.; and *absolute*, as "jar," "web," "wall," "granary," "hearth," "sacrificial floor," "cowpen," &c.

(7). Now we have to set forth the second part of Logic, which treats of Propositions.

*Aphorism XLVI.*

Propositions considered merely as *Sentences*, are of two kinds, *categorical*

[—i. e., "asserting simply the relation between the Subject and Predicate," —]; and other than such.

(1). Such a proposition as "The mountain is fiery" is of the first kind. The second kind is of two sorts, *Conditional*, and *Disjunctive*. Such a propositions as "If it were not fiery it would not smoke," is Conditional. "Either the world is due to chance, or it must have had an intelligent maker," is a disjunctive proposition. This division of proposition is according to their *substance* [—i. e., considered simply as *sentences.*]

*Aphorism XLVII.*

But, according to their character as *propositions*, they are first divided into *affirmative* and *negative*.

(1). E. g.,—"The mountain is fiery,"—and "The lake is *not* fiery."

(2). The division of them, according to their *matter*, into *true* and *false*, since it belongs, not to the present enquiry, but to this or that other science which deals with that matter, is not here taken account of.

(3). Now a *second* division of them, according to their character as Propositions, is to be mentioned.

*Aphorism XLVIII.*

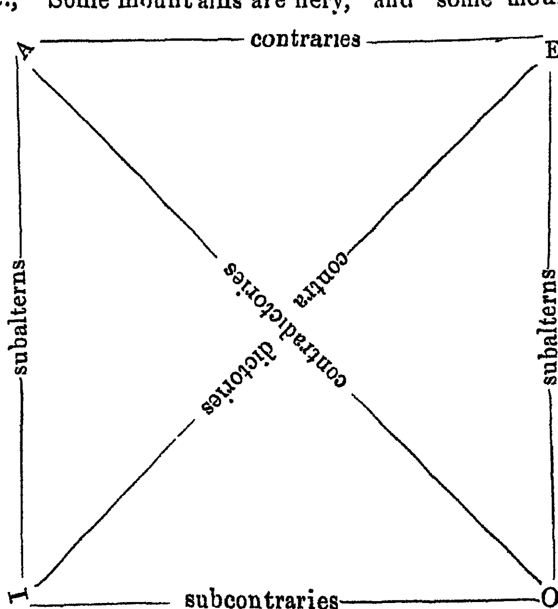
A second division is into *universal* [—literally, "those in which the Predicate is said in respect of the whole of the Subject"*—], and *particular*.

(1). E. g., "*All* mountains are fiery;" and "*Some* mountains are fiery." That the *Subject* is spoken of in its whole extent, is understood from the word "all;" and that it is spoken of partially, is understood from the word "some:"—but how we know whether the *Predicate* is employed in its whole extent, or only partially, we proceed to explain. All *negative* Propositions necessarily speak of *all* the things negatively predicated [—i. e., they distribute the Predicate:]—as, e. g., "The lake is not fiery;"—here the word "fiery" embraces *all* fiery things [—and the lake is something different from every one of these]. But *affirmative* Propo sitions do not necessarily speak of all the things of which the Predicate is a name. Thus, in the proposition "The mountain is fiery," we are not informed that the mountain [is *all* fiery things,—that it] differs not from hearths, courtyards, cow-pens &c., having fires in them [—though they are not mountains]. Thus while all Universal Propositions distribute the *Subject*, all *Negative* Propositions distribute the *Predicate*. But then, if you say—where the extent of the Predicate coincides with that of

* The Sanskrit terms here employed are as follows. A "Universal Affirmative" is *avachchhedakávachchedena vidháyaka*,—literally "affirmative according to the limit of the distinguishing nature." Thus, when we assert that "All men are mortal," we are predicating mortality in the entire extent of the presence of the "distinguishing nature" *humanity*. A "Particular Affirmative" is *sámánádhikaranyena vidháyaka*,—literally "affirmative of their being associated [but not universally]." Thus, when we assert that "Some men are blind," we are not predicating blindness throughout the entire extent of the presence of that *distinguishing nature* which constitutes one a man, but only asserting the accompaniment of humanity by blindness, e. g., in the particular men spoken of. These are recognised and familiar Sanskrit terms. If, when written out in European characters, they look not much more manageable than some of the new chemical terms devised in this Synopsis, the expectation is reasonable that the new terms will not be found much more unmanageable than these.

the Subject,—e. g., in the instance "Every Substance is possessed of Qualities,"—the proposition, distributing the predicate also, includes every individual case of what possesses qualities, since qualities nowhere exist in what is not a substance;—we reply,—true;—but this is known through our knowledge of the *matter*, not simply from an inspection of the *form* of the proposition. But we are here concerned, as we have already stated, with those properties of propositions alone, which are revealed by the form of the proposition.

(2). We shall now mention the technical symbols for the various kinds of propositions, which symbols are employed to facilitate that consideration of syllogistic forms which is to be made in this Section. Thus, a Universal Affirmative is to be understood by the letter A; a Universal Negative by E; a Particular Affirmative by I; and a Particular Negative by O. A quaternion of relations determines the mutual Opposition of these four varieties of propositions. To explain:—A and O, and similarly E and I stand mutually in the relation of Contradictories [—literally, in the relation of what are, adequately for the assertion, excluder and excluded—]. Such is the relation between "All mountains are fiery," and "Some mountains are not fiery;" and, again, between "No lakes are fiery," and "Some lakes are fiery." A and I, as also E and O, stand in the relation of container and contained [—or subalternant and subaltern—]; as is the case with "All mountains are fiery," and "Some mountains are fiery;" or with "No lakes are fiery," and "Some lakes are not fiery" A and E stand in the relation of contrariety [—literally, of more than mere contradictoriness]. Such is the relation between "All mountains are fiery, and "No mountain is fiery." I and O stand in the relation of compatibility:—such is the relation of these two, *viz.*, "Some mountains are fiery," and "some mountains are not fiery.'' In this Section we are particularly concerned with Contradictory opposition alone, and not with Contrary opposition,—because the notion that "All men are honest," or that "No man is honest," can be repelled by proving that "Some men are not honest," and that "Some men are hones," since a particular exception suffices to debar a universal assertion. What has been here said in regard to the Opposition of Propositions, may be made clear by constructing a diagram,—such as is here shown:




(3). Now we have to consider the *conversion* of Propositions,—in regard to which here is an aphorism.

*Aphorism XLIX.*

The making the subject of a given proposition its Predicate, and the Predicate its Subject, is called the conversion of the proposition.

(1). In this Section, of Formal Logic, we are concerned only with *illative* conversion, since such alone can be ascertained to be allowable by mere inspection of the form of the proposition. To explain. That is called *simple* conversion, where the Subject and Predicate, of a given proposition, unaltered, become the Predicate and Subject. For example;—"No lake is fiery," may be illatively converted into "Nothing fiery is a lake." Where no term undistributed in the exposita is distributed in the converse, the simple Conversion is illative. Hence E and I may be simply converted illatively, because, a Universal Negative, denoted by E, distributes both terms; and a Particular Affirmative, denoted by I, distributes neither. But since a Universal Affirmative, denoted by A, does not distribute the Predicate, its simple conversion is not illative;—for, from knowing that "Whatever is smoking is fiery," we cannot know for certain that "Whatever is fiery is smoking;"—for, in that case, we should have the term "fiery," which was not distributed in the exposita, distributed in the converse. Hence when this has to be converted, having *limited* the extension of the word "fiery," we may lay down that "*Some* fiery things are smoking;" and this is quite illative. This is called *conversion by limitation* [—or *per accidens.*—] A Universal Negative, denoted by E, may thus be converted also. But in the conversion of a Particular Negative, denote by O, since, inasmuch as whether the [new] Subject be taken distributively or not, the [new] Predicate, previously undistributed, becomes distributed, such conversion cannot take place,—we must cease to regard the proposition as a *negative*, and must regard it as an affirmative with a *negative Predicate.* Thus it becomes one denoted by I,—and then it may illatively be simply converted. For Example:—"Some substances are not coloured," cannot be illatively converted into "Somé coloured things are not substances,"—because, in the latter case, the term "substances" is distributed, while it was not distributed in the former. But, ceasing to regard the proposition as denying the predicate "coloured," and having changed the proposition from a negative to an affirmative by regarding it as affirming the absence of colour, the proposition can be simply converted into "Some colourless things are substances. This is called Conversion by *negation* [or by *contraposition,*—or, as we have rendered it, conversion by attaching the negative to one or other of the terms,—*viz.*, in this case, to the predicate of the original, which then becomes the subject of the converse]. And this can take place also in the case of a Universal Affirmative, denoted by A:—*e. g.*, "All smoking things are fiery" may be illatively converted, by negation,—attaching a negative to each term,—into "What is not fiery is not smoky." And thus, in one or other of the three ways here described, every proposition may be illatively converted;—*viz.*, E and I *simply*; A and E by *limitation*; A and O by *negation,*—the negative being attached to one term in the case of O, and to both in the case of A.

(2). Now have to set forth the nature of the *Syllogism.* In regard to this, the author of the *Vedánta-paribháshá* holds that the members of a Syllogism are only three, viz., the first three, or the last three, in the five-membered exposition. Although we agree with him, yet in the present Section we shall treat the Syllogism as consisting invariably of those three

members of which the Conclusion comes *last*. A Syllogism is made up of two parts; that which is *proved*; and that *by means of which* it is proved;—for there is first exhibited, by the major and minor premises, a Reason [or Middle Term] ascertained to be distributed, and to be predicable of the Minor Term; and then there is set forth, in the Conclusion, something not previously ascertained, but to be proved, and which can be obtained through the force of the Reason aforesaid.

(3). And since Formal Logic is concerned with the *form* of Syllogisms alone, such syllogisms only are to be here employed as can be ascertained to be conclusive or not, without enquiring into the *meaning* of the words serving as the predicate, the reason, and the subject, by a mere examination of the form. For example;—from the premises "whatever possesses the Reason, possesses what is to be proved;—and this Subject possesses the Reason;"—the conclusion that "This Subject possesses what is to be proved" necessarily follows, whatever things be meant by the words "Subject," "what is to be proved," and "Reason," as they stand there. To a form like this the other forms of correct argument are ultimately reducible.

(4). Now, when the premises of a perfectly valid syllogism are false, it does not necessarily follow that the conclusion resulting from their combination shall be false. And where either of the premises is only *probable*, there we can infer only a *probable* conclusion. To exemplify the former case,—suppose "All men are honest,"—even from this false premiss, with the co-operation of the other true premiss "Ráma is a man," a true conclusion follows; while the equally true minor premiss "Kansa is a man" produces the false conclusion that "Kansa is honest." But wherever a conclusion is found to be false, there one or other of the premises must necessarily be false; since, if they were true, the conclusion must necessarily be true.

(5). It is in accordance with this that the "*indirect* mode of proof" (*tarka*) is frequently employed for establishing what we maintain. For an *indirect* argument consists of a minor premiss taken along with a major premiss, admitted by both disputants, which establishes the falsity of the contradictory of what is maintained [—in other words the *truth* of what is maintained]. For example, whosoever admits that "whatever smokes is fiery," and conversely "whatever is not fiery does not smoke;" if he, admitting that the mountain is smoking, says that there is *not* fire in the mountain,—then, in order to refute him, an indirect argument is employed,—in the shape of the [palpably] false imputation of a Major [viz., "smokeless"] by means of the false imputation of a Minor [viz., "fireless," —which the opponent contends for];—thus, "If the mountain were fireless, then it would be smokeless;* and hence, that the firelessness is false, is proved by the falsity of the smokelessness,—since you admit that there *is* smoke in the hill;"—and thereby it is determined that the mountain *is*

* The indirect mode of proof is thrown by Hindú writers into the hypothetical form, the form in which it is employed in every day life. Euclid, after saying, "Well, for the sake of argument, let us suppose that you are right,—and now see what follows,"—would have exhibited the reasoning categorically;—thus

"What is not fiery does not smoke, [—Agreed]:—
The mountain is not fiery, [—you insist]—
Therefore the mountain does not smoke, [—which,
However, you agree with me it does]."

fiery;—for, though, from a false assumption, it is not certain whether truth or falsehood will follow, yet, from a true assumption, truth only can follow.

(6). Now, intending to explain the ground of the validity of such a form of argument as "Whatever possesses the Reason possesses what is to be proved; this Subject possesses the Reason; therefore this Subject possesses what is to be proved,"—Aristotle employs the following maxim, viz., "Whatever is affirmed or denied universally, may in like manner be affirmed or denied of the particular cases included."

(7). To facilitate the determination of the validity of other syllogistic forms, to which the maxim cannot be directly applied without inconvenience, other rules are applied;—as follows.

(8). *Every syllogism has but three terms*: *viz.*, the minor-term, the major-term, and the middle-term. Of these, the minor-term (*paksha*) is the Subject of the conclusion; the major-term (*sádhya*) is the Predicate of the conclusion; the middle-term (*hetu*) is that, the relation of the major-term to which is set forth in the major premiss (*udáharaṇa*), while its relation to the minor-term is set forth in the minor premiss (*upanaya*). When therefore one [middle-term] is predicated distributively, and another is predicated of the minor-term, since the relation of the minor and major-terms to one and the same middle-term has not been shown, the relation of the minor and major terms to each other cannot be inferred.

(9). Hence *every syllogism has only three separate propositions*; *viz.*, 1st, the major-premiss, which exhibits the relation between the Reason and, what is to be proved, [i. e., between the middle and major terms]; 2nd, the minor-premiss, which exhibits the relation between the Reason and the Subject of the conclusion, [—i. e., between the middle and minor terms]; and 3rd the conclusion, which exhibits the relation of the minor and the major terms. The Proposition and Reason, which are also reckoned by the Naiyáyikas as members of the Syllogism, do not differ at all from the Conclusion and the Minor Premiss, [of which they are amplificatory repetitions, like those in Euclid's Elements, for rhetorical convenience*].

(10). *If the middle-term is ambiguous, then there may be more than one middle-term expressed by a single sound.* And this ambiguousness is sometimes occasioned by there being more senses then one. For example,—"All light (*ruk*,—which means also "disease"—) is the opposite of darkness; and a fever is a disease; therefore it is the opposite of darkness." Sometimes, again, the cause of ambiguity is the middle-term's standing for only a *part* of its whole *significates*:—e. g., "White is a colour; and black is a colour; therefore white is black":—here if *all* colours had been understood, then, from the judgment that both white and black were *all colours*, it would be established that black is white. But this is not the case [—that *all* colours were understood—], because the Predicate of an affirmative proposition does *not* stand for the whole of its significates. Therefore the middle-term must be distributed at least once in the body of the Syllogism; and this may take place in two ways, viz., through its being the Subject of a Universal (whether affirmative or negative,) or its being the Predicate of a Negative. And in this way, if the Subject or Pre-

* Any one who forgets that Rhetoric is "an off-shoot of Logic," and (—considered scientifically, not with vulgar laxity,—) is concerned about *proving*, as Logic is concerned about *inferring*, must not expect to understand what is said above, See our version of the *Tarka-sangraha*. Ed. 2nd, p. 45.

dicate of the conclusion has been compared to the *whole* of the middle-term, and the other extreme has been compared to a *part* of it, [they must have both been compared to the same, and consequently] the conclusion will be valid.

(11). *No term which was not distributed in one or other of the premises, must be distributed in the conclusion,* because, if a term which had been employed in the premises in only a part of its extent, were employed in the Conclusion in the whole of its extent, we should find that in reality a fourth term had been introduced,—viz., by there being an *illicit process of the major*, or an *illicit process of the minor*. An illicit process of the major is as follows:—e. g., "All quadrupeds are animals; a bird is not a quadruped; therefore it is not an animal." In this argument the term "animals," in the major premiss, does not include *all* animals, because it is the Predicate of an *Affirmative* Proposition; but, in the conclusion, it does include all animals, because it is the Predicate of a *Negative* Proposition. An *illicit process of the minor* is as follows:—"What is declared in the scriptures of the Bauddhas is unworthy of respect; morals are declared in the scriptures of the Bauddhas; therefore morals are unworthy of respect":—for here there is an illicit process of the minor, in as much as, in the conclusion, it is asserted that morals universally are unworthy of respect; while, in the minor premiss, it is indisputable that the term "morals" applied only to *Buddhistic* morals. And here it might have been a valid conclusion that *some* morals are undeserving of respect; but in the case of illicit process of the *major*, no conclusion whatever can follow legitimately from the premises;—such is the distinction between the two cases.

(12). *From two negative premises nothing follows*; for in these there is no declaration of a Subject possessing a character in respect of which something is predicated distributively. For example,—nothing can be inferred from such premises as "Nothing aqueous is fiery, and nothing stony is fiery."

(13). *If one or other of the premises be negative, only a negative conclusion can be legitimate*; for, the middle-term being known to disagree with only one or other of the extremes, it is impossible that the extremes should agree. In the same way it is evident that where the conclusion is negative, one of the premises must necessarily be negative.

(14). By these six rules all categorical syllogisms can be tried; and from these it is evident that *nothing can be inferred from two particular premises*; since then either the middle-term will be undistributed, or else there will be an illicit process of the minor or of the major. Thus if both premises were I, viz., particular affirmatives, nothing would follow, because the middle-term [as well as the others] would not be distributed; and from the combination of a major I, particular affirmative, with a minor O, particular negative, there results [by the rule under § 13] a negative conclusion; and since, in this conclusion a term would be distributed which was not distributed in the premises, there would be an illicit process of the major. For example;—"Some animals are sagacious; some beasts are not sagacious; therefore some beasts are not animals." Here no term is distributed except the predicate of the minor premiss, viz., "sagacious," which, else we should have an undistributed middle, we must suppose to be the middle-term; but, in the conclusion, the term "animal" is distributed, which was not distributed in the premises;—so that there is here an illicit process of the major.

For the same reason, if one of the Premises be particular, the Conclusion also must be particular. Thus, in the example given above, viz., "What is declared in the scriptures of the Bauddhas is unworthy of respect; morals are declared in the sciptures of the Bauddhas; therefore morals are unworthy of respect;" since the term "morals," in the minor premiss, stands for only *some* morals [—viz., the Buddhistic—], it is legitimate to infer, in the conclusion, only that *some* moral rules are undeserving of respect: because if the conclusion were universal, there would be an illicit process of the minor. Further, from two universal premises we cannot always infer a universal conclusion. For example; from "All gold is precious; and all gold is mineral;" we can infer only that "therefore *some* mineral is precious," but not that *all* minerals are such; because, since *all* minerals are not intended by the term "mineral" in the minor premiss, we cannot speak of *all* minerals in the conclusion.

(15). Now we have to consider what forms [or Moods] are produced by combining the four symbols, viz., A, E, I, O, which have been already exhibited as serving to indicate whether propositions are Affirmative or Negative, Universal or Particular. Well, by combining a major premiss of each of these four kinds with a minor premiss of each of the four kinds, sixteen different pairs of premises are produced; and on attaching to each of these a conclusion of each of the four kinds, sixty-four different forms of syllogism are obtained. Of these, eleven, which, under the conditions to be described, are valid, shall be here treated of. But the other forms, which are in every case invalid, may be tried by intelligent readers for themselves [by the rules under §§ 8—13].

(16). Among these [eleven allowable Moods] not all are allowable in every situation of the Middle-term [with respect to the extremes], but only certain of them in each. There are *three* positions of the Middle-term. Where the Middle-term is the Subject of the Major Premiss and the Predicate of the Minor Premiss, that is the First Figure, [—or arrangement of the middle-term]. Where the Middle-term is the Predicate of both premises, that is the Second [Figure]. Where the Middle-term is the Subject of both premises, that is the Third [Figure]. A fourth Figure also, the reverse of the First, is mentioned by some, but, [being, according to Whately, "the most awkward and unnatural of all," being the very reverse of the First, and not being recognised by Aristotle at all,] shall not be employed here. By knowing the *Figure*, we know only the situation of the Middle-term, as subject or predicate; but whether the propositions may be Affirmative or Negative, and Universal or Particular, remains to be considered. The Major Premiss is the proposition which declares the relation of the Major Term to the Middle Term. The Minor Premiss is the proposition which declares the relation of the Minor Term to the Middle Term. The Conclusion is the proposition which declares the relation of the Minor Term to the Major Term. Therefore, by a change of *order* [in the statement of them], these do not change their character. Still, the established arrangement, of placing the Major Premiss first, the Minor Premiss second, and the Conclusion last, as it is the most convenient, is to be adhered to.

(17). We remarked that all the allowable Moods are not legitimate in every Figure. To explain. The Mood I A I is allowable in the Third Figure:—thus, "Some things that have the Reason have what is to be proved; whatever has the Reason is the Subject; therefore in some cases the Sub-

ject has what was to be proved ."—but in the First Figure it is not allowable. For example,—"Some things that have the Reason have what is to be proved; whatever is the Subject has the Reason; therefore in some cases the Subject has what was to be proved:"—here the middle-term is not distributed, for it is the subject of the major-premiss [here a particular affirmative], and the predicate of the [affirmative] minor-premiss. So, though A E E is allowable in the Second Figure, thus—"Whatever has what is to be proved has the Reason; nowhere has the Subject the Reason; therefore the Subject has not what was to be proved;" yet in the First Figure it is not allowable,—thus "Whatever has the Reason has what is to be proved; nowhere has the Subject the Reason; therefore the Subject has nŏt what was to be proved;"—for there is here an illicit process of the major,—the predicate of the conclusion being distributed, as it is the predicate of a negative proposition,—whereas it is not so in the major premiss, where it stands as the predicate of an affirmative proposition. So again A A A is allowable in the First Figure,—thus, "Whatever has the Reason has what is to be established; everywhere the Subject has the Reason; therefore everywhere the Subject has what was to be established:"—but it is not allowable in the Third Figure, —thus, "Whatever has the Reason has what is to be established; whatever has the Reason is the Subject; therefore whatever is the Subject has what is to be established;" for there is here an illicit process of the minor, inasmuch as the minor-term is not distributed in the minor premiss of which it is the predicate, whereas it is distributed in the conclusion by its being the subject of a Universal Affirmative.

(18). Now, on applying the sixty-four Moods above-mentioned to each of the three Figures, six Moods alone in each are found to be admissible, as not violating the above-mentioned six rules against the three faults of *illicit process of the minor or major*, and *undistributed middle*; and of these eighteen, four are neglected, in which a particular conclusion is drawn, when a *universal* conclusion was allowable. These four are A A I and E A O in the First Figure, and E A O and A E O in the Second Figure. And so, in order to impress concisely and easily on the memory, which of the useful Moods is legitimate in each Figure, and how each of the legitimate Moods in the Second and Third Figures may be reduced to the First Figure, the following mnemonic lines have been devised:—viz.,—

*Aphorism L.*

Fig. 1. bArbArA, cElArEnt, dArII, fErIOque, prioris.
Fig. 2. cEsArE, cAmEstrEs, fEstInO, bArOkO, secundæ.
Fig. 3. { tertia dArAptI, dIsAmis, dAtIsI, fElAptOn,
bOkArdO, fErIsO, habet——

Such are the available Moods in the several figures.

(1). The initial consonants (b, c, d, and f,) in the first verse, indicate that the syllogistic forms exhibited in the other verses, and named by words beginning with the same consonants, can be reduced to the form of the syllogism in the First Figure, named by a word beginning with the same consonant. The letter *s* informs us that when the syllogism is to be reduced to the First Figure, the proposition indicated by the vowel immediately preceding the *s*, is to be "*s*imply converted." The letter *p* informs us that the conversion is to be "*p*er accidens" [or "by limitation"]. The letter *m* informs us that the premises are to be transposed, the Major Premiss becom-

ing the Minor, and vice versâ. The letter *k* informs us that the proposition, denoted by the vowel immediately before it, must be left out, and the contradictory of the Conclusion be substituted. The above lines are to be committed to memory by those who wish to distinguish the legitimate from the illegitimate forms of argument.

(2). On examining these technical lines, it will be perceived that the Conclusion A is legitimate in the First Figure only; negatives alone can be proved in the Second Figure; and particulars alone in the Third Figure. The reason why only negative conclusions are legitimate in the Second Figure, is, that, since the middle-term is the predicate in both premiss, it would not be distributed unless one or other of the premises were negative; and if a premiss be negative, the Conclusion is necessarily negative.

(3). When we wish to reduce any legitimate syllogism to the form of one of the four Moods of the First Figure, we are to assume nothing beyond the truth of the premises, and we are not to introduced any new term: but, where necessary, it is allowable illatively to convert the premises, simply or by limitation; and, this having been done, we can obtain, in the First Figure, either the same conclusion as before, or another from which the original conclusion follows by illative conversion.

(4). To simplify the understanding of this matter for the student, one Mood in each Figure is given by way of example. E. g, in the First Figure, viz., (*bAr*) "Every H is S; (*bA*) Every P is H; therefore (*rA*) Every P is S; we might have the following argument,—viz.,

"All that smokes is fiery;
"All mountains smoke; therefore
"All mountains are fiery."

(5). In the Second Figure,—(cAm) "Every S is H; (Es) no P is H; therefore (trEs) no P is S." Example,—

"Whatever is fiery smokes;
"No mountain smokes; therefore
"No mountain is fiery."

(6). In the Third Figure,—(dA) "Every H is S; (rAp) every H is P; therefore (tI) some Ps are S. Example,—

"Whatever smokes is fiery;
"Whatever smokes is a mountain; therefore
"Some mountains are fiery."

(7). Now we have to show how syllogisms in the Second and Third Figures may be reduced to the First Figure. Examples are exhibited in order to render this clear. E. g, *dArAptI*.

(dA) "All things smoking are fiery;
(rAp) All things smoking contain damp fuel;—therefore
(tI) Some things containing damp fuel are fiery;"

in such a case as this the letter *p* informs us that the proposition indicated by the immediately preceding A, the Universal Affirmative, the Minor premiss, is to be converted *per accidens* [or by limitation]; and thus the minor

Premiss having become Particular, the argument appears as follows—

(dA) "All things smoking are fiery;
(rI) Some things containing damp fuel smoke; therefore
(I) Some things containing damp fuel are fiery."

Thus the argument is reduced to a mood of the First Figure [viz., *dArII*] indicated by the initial *d* [of *dArAptI*].

(8). And *cAmEstrEs*—

(cAm) "All things smoking are fiery;
(Es) No body of water is fiery; therefore
(trEs) No body of water smokes",—

in such a case as this, we are informed by the letter *s* that the Universal Negative, the Minor Premiss, denoted by the E, is to be *simply converted*, —so that it still remains denotable by E. Then by the letter *m*, standing after the A which denotes the Universal Affirmative, the Major Premiss, we are informed that the premises are to be transposed. The final *s* further informs us that the Conclusion is to be *simply converted*; and previously to converting it we get the following—

(cE) "Nothing fiery is a body of water;
(lA) Whatever smokes is fiery; therefore
(rEnt) Nothing that smokes is a body of water."

Thus is this reduced to the mood *cElArEnt* of the First Figure, as was indicated by the initial letter *c*. The Conclusion may be illatively converted into the orginal one by *simple conversion*.

(9). Now we must explain why *bArOkO* and *bOkArdO* have *b* as their initial consonant. It is to indicate that they may be reduced into the form *bArbArA*. For example—

(bA) "Whatever smokes is fiery;
(rOk) Some mountains are not fiery; therefore
(O) Some mountains do not smoke":—

—in such a case as this, the *k*, standing after the Particular Negative, the Minor Premiss, informs us that, if the conclusion be denied,—i. e., if its contradictory be asserted,—this Minor Premiss is to be thrown out, and the *contradictory* of the original *Conclusion* to be substituted in its room. In the foregoing example the contradictory of the original conclusion is "All mountains smoke,"—which if any one assert, it follows that "*All* mountains are fiery,"—which contradicts the originally admitted Minor Premiss:—thus—

(bAr) "Whatever smokes is fiery;
(bA) All mountains smoke; therefore
(rA) All mountains are fiery."

(10). So of *bOkArdO*—

(bOk) "Some bodies of water are not fiery;
(Ar) All bodies of water contain the Vallisneria; therefore
(dO) Some things that contain the Vallisneria are not fiery."

In this case, in accordance with the previous directions, having thrown out the Major Premiss, let the contradictory of the Conclusion be substituted; and then the Conclusion will be opposed to the original Major Premiss:—Thus—

(bAr) "All things that contain the Vallisneria are fiery;
(bA) All bodies of water contain the Vallisneria; therefore
(rA) All bodies of water are fiery."

(11). This reduction is called 'reductio ad absurdum,' because thus the person disputing the validity of a syllogism in *Baroko* or *Bokardo* is shown to contradict a premiss which he had previously assented to.

(12). Let us now illustrate the way in which the enquiry as to the validity of a chain of argument may be properly conducted. As a simple case, let us take the 1st Prop. of Euclid. Euclid there asserts that a certain triangle A B C is equilateral.—This assertion really involves three several assertions, viz. that the side AC is equal to the side AB, BC=AB, and AC=BC. The first of these assertions is proved as follows.—

All radii of the same circle are equal;
AC and AB are radii of the same circle;—
Therefore AC and AB are equal.—

This is a syllogism in bArbArA, and is therefore logically valid.—Either the conclusion must be accepted or one of the premises must be impugned. Suppose the major is impugned, we make it our conclusion and proceed to adduce premises in support of it; thus,—

The definitions of a science such as Geometry and the like must be granted, if there is to be any reasoning on the subject at all;—

The character of equality in its radii is the Geometrical definition of a circle;—

Therefore the equality of the radii of a circle must be granted, if we are to have any reasoning in Geometry at all.

This also is a Syllogism in bArbArA and logically valid. The propriety of the Major is self evident; and as for the Minor, Euclid has no debate with one who objects to what he places in the list of definitions prefixed to his Elements.

Again, suppose that the Minor of the first syllogism is impugned, and that the objector says it is not self evident that "AC and AB are radii of the same circle;" we reply as follows:—

If there is to be any argument at all, then wherever I require a circle with a given centre and a given length of radius, there that circle must be allowed to exist;—

In the present instance I require a circle with the centre A, the radius AB, and in which AC shall be another radius;—

Therefore AC and AB are radii of the same circle.

Here again the syllogism is valid. The Minor is self-evident, because each man is the authoritative enunciator of his own requirements. If you do not admit the Major, then Euclid will not continue the discussion with you; and, in order that you may be aware of the terms on which he will consent to reason with you, he lays down, as one Postulate among others, the right to assume a circle with any centre that he chooses and any length of radius.

The equality of BC and AB is established in the same way. It remains that we enquire what proof there is of the equality of AC and BC. Syllogistically stated it is as follows.

All things which are equal to the same thing are equal to one another: AC and BC are each equal to AB; Therefore AC and BC are equal.

Here again the syllogism is valid. The Minor has been already established. The Major, in Euclid's opinion, is self-evident; and, in order to intimate that he holds no debate with any one who asks a proof of that assertion, he places it, at the opening of his Elements, in a list of what he himself holds to be Axioms, or truths which carry their own evidence along with them.

When a chain of arguments is tested in this way, then perhaps sometimes, on the opponent's pointing out a defect in some particular argument, the proponent, being a logician, may surrender that argument. Or, on the other hand, some premiss may occur, which the proponent holds to be self-evident, while the opponent demands proof of it;—so that since, on this alternative, he, regarding the thing as *self-evident*, cannot himself exhibit *proof* of it, and since the opponent cannot be satisfied without the exhibition thereof, everything else that could be uttered by the proponent must be mere haggling and squabbling,—there is an end of [what we have spoken of as the] Conversation [of persons agreed upon first principles]. So much for the subject of "Conversation."

Here ends the section on Inference. Well, in the commentary on the third aphorism of the First Book, *Testimony* was stated to be evidence, as being a kind of inference; and in the seventh aphorism Testimony was defined as the declaration of one worthy [to be believed]. We now mention three qualities in a speaker which acquaint us with this worthiness in him who bears testimony.

## Section VI.—Testimony.

### *Aphorism LI.*

The three marks of worthiness [in him who bears testimony] are honesty, the having directly cognized, and the power of distinguishing between truth and falsehood.

(1). The meaning is this. The credit due to the words of the dishonest is simply a matter of doubt. Further, even an honest man, if he did not actually witness the thing, cannot certify to the truth of the matter. Further, even an honest man, though he may have actually witnessed the thing, cannot tell the truth in regard to it, if he be incompetent to distinguish what is true and what is not true in the matter. Hence it is that the three marks of trust worthiness above-mentioned are indispensable in the man who testifies to any matter. So too this same is the mark of the trust-worthiness of him who reports the testimony of others,—the matterth [in respect of which the testimony is given] being in that case e others' declaration.

(2). Now we cite, for the purpose of making clear this subject, the couplets 486—572 of the first chapter of Mr. Muir's *Mata-parikshá.*

"It appears that the accounts of former events which are received by tradition are sometimes deserving of credit, and sometimes not. For one particular account appears to possess proof, and another, on examination, appears to be destitute of proof. Hence in order to distinguish whether

such and such a tale of ancient events deserves credit or not, let its specific character be considered. When, where, from whose mouth did the story spring? Of what character, and how numerous were its first hearers? Was it committed to writing soon after it arose, or received by mere oral tradition from the ancients? By examining these and such like characteristics of a story, discerning persons will know whether it is true or false.

"But in order that my meaning on this subject may be clear, I will explain it at length to the best of my power. You know that there is a great difference among men, arising from a variety of causes, natural character, place, time and the like. Some men are dull, ignorant, undiscerning, without independence, devoid of knowledge, credulous and rude. And others are lettered, clever, possessed of knowledge, reflecting, of independent minds, free from credulity, and seekers after truth. And it is well known in the world that the people of various countries, who were at first sunk in ignorance, have ultimately attained to eminence in knowledge. As long as the people of any country are ignorant, so long does their power of judgment continue feeble. Hence such people do not properly understand what stories are probable and supported by proof, and what (tales) are not so. Whatever ancient account of former (events) they hear, they quickly drink in with their ears* and believe without examination. But when the people of any country have become possessed of knowledge, their discrimination increases exceedingly. Hence these persons, (being) clever, are competent to test what stories are supported by, and what are destitute of, proof, and so forth. Such persons, hearing any ancient story, do not hastily believe it, but prove it in every way. Hence (it was that) I said that one (thing) to be ascertained by those who are devoted to truth is, *Of what character were the first hearers of the history.*

"Further, it should be ascertained by those who seek to know the truth; *Who and of what character was the first narrator of the ancient occurrence?* Here it should be seen whether he was a good, wise, and disinterested man, acquainted with history, or an interested and fraudulent person, and so forth. For some of the narrators of ancient histories, (being) of fraudulent disposition, invent, and tell unreal tales for selfish ends.

"And it should be further ascertained *at what time and where* such and such a story arose, and *when* it was committed to writing. If any story, without being committed to writing, has for a great length of time been merely orally received from the men of old, it will merit suspicion. For the narratives of ancient events, when not committed to writing, almost all undergo further and further alterations.

"I (will) now make plain by two illustrations what I have said in regard to the examination of ancient narratives.

"In former times the mighty Persian emperor, bringing a formidable army, invaded the country of Greece † From that invasion, O Pandit, to the present time, about two thousand three hundred years have elapsed. The Greeks being fearless, though few, overcame in many battles the army

* "This metaphor, though it sounds harsh in English, is quite admissible in Sanskrit."

† "The idea of this illustration has been derived from Mr. Issac Taylor's able and interesting work 'The Process of historical proof explained and exemplified,' in which he shews by a detailed examination of the case of Herodotus, what are the elements and conditions of historical credibility. These tests are then applied to some of the Christian records."

of the foe, and expelled it from their country. At the time when the powerful lord of Persia made (this) invasion, there was in the Grecian country a certain child. That person, Herodotus by name, when he had attained to manhood, desired to narrate the true history of this war. At that time many men (who were) witnesses of all the events of that great war, were in existence. Having ascertained from the mouth of those witnesses the particulars of the war, Herodotus composed its history in prose. At the commencement of the book the history of the Persians and other foreign people is narrated by the author. From a desire to know the history of those foreign nations he, being distinguished by great activity, travelled about even in distant foreign lands; and collected from the lips of the persons in those countries who were acquainted with history the ancient accounts of each.

"When the composition of his history was finished, it was recited in some of the assemblies of the Greeks. Certain great games were observed in that country, at which the Greeks of all countries always met. When the people were on one occasion collected at these games, Herodotus repeated his history to the whole assembly. Afterwards this scholar Herodotus, desirous of repeating his work, came to a Grecian city called Athens. That city was very renowned among the Grecian cities, and its inhabitants were celebrated for their ability. And those citizens of Athens, occupying the post of danger strove with great heroism to destroy their enemies. The Athenian citizens being then collected in assembly, the author then again read in their presence the work composed by him. Many of those auditors having been themselves soldiers had formerly fought against the Persians at the time when their country was invaded. And the others, who were children at the time of the country's invasion, had repeatedly heard the account of it from their fathers' lips. Hence all the hearers too knew before-hand the substance of the narrative which the historian then read. And at that time those inhabitants of Athens were neither rude nor undiscerning, nor ignorant. Many of them were clever, gifted with knowledge, discerning, of independent minds, not prone to credulity. And it is notorious in the world that even the common people of that city were acute, and inquisitive. In presence of such people, collected in assembly, Herodotus then read the account of the great war. It cannot therefore seem to my understanding likely that he should have delivered an unreal account to such instructed and clever people. In that country, Greece, there were many districts, and the government of each district was separate. The people of those several districts, owing to this multiplicity of governments, were jealous of each other, as persons acquainted with history know. Hence Herodotus could not in the least conceal any act of valour which the people of any of the several districts had performed. But if he had eulogized any of them in an exaggerated way, the people of the other districts would certainly have found fault with him. Hence there is no doubt, O Pandit, that the history which he composed of that war is in every respect trustworthy. It is also completely ascertained that the said history being composed at that period became then current. A succession of other authors assert the existence of the work from the time of its composition continuously till now. And there is no doubt that these authors who declare the existence of the work are themselves well known and of ancient date. If you wish to test the details of all this, O Pandit, there are many books on the subject which are easy to be had. And so

the antiquity of the history composed by Herodotus to which I allude, is ascertained.

"I said that the part of his history in which he narrated the Persian war is trustworthy. I said formerly that the ancient history of the kings of Persia and other countries is told at the beginning of the book. And I said that Herodotus traversing Persia and other foreign countries, diligently investigated their respective histories. But the foreign history which he thus collected, from its antiquity, and other causes, is not understood to be very deserving of credit. He could not properly verify the old stories which he heard from the lips of the people of those several countries. For he did not reside long there, and did not know thoroughly the peculiarities of their people. And the stories which he heard from the mouth of the men of those countries, frequently relate to very ancient occurrences. Hence the foreign history which he related, is mostly not very trustworthy, from the events being unascertained. And thus, O Pandit, the celebrated book composed by Herodotus is divided by learned men acquainted with ancient history into two parts. The learned regard as trustworthy the account which that sage gave in his book of the war in his own time. But the intelligent do not place the same confidence in the foreign history which he narrated. The learned consider that though desirous of telling the truth, he could not perfectly ascertain the former history of foreign lands.

"In order, Sir, that I may make this matter quite clear. I shall now give another illustration of it. There was another famous Grecian scholar named Plutarch, a delightful writer on various subjects. It is ascertained that from his time to the present day about 1800 years have elapsed. He composed the histories of Roman and Grecian kings, generals, and learned men previous to his own time. Some of the kings and others whose history he narrated lived a thousand years before him. But many others of them lived on earth a short period before the author's time. The author could correctly ascertain the actions of the kings who lived a little before him. For former scholars, contemporaries of those kings, committed to writing many of their actions. But he could not ascertain the real history of those very ancient kings whose story he told. For when those ancient kings lived, there was no scholar skilled in the composition of books. And if any poet afterwards celebrated their deeds, he from exaggeration invented much that was untrue in his poem. But such poems narrating the deeds of kings were not committed to books for a very long time. When Plutarch composed the story of those ancient kings, there was no source for their history but (these) poems. Hence the history of ancient kings extracted from poems, which Plutarch composed, is not considered trustworthy."

(3). Having thus described the three qualities in a trustworthy witness, as connected with the question of the validity of Testimony, now since the employment of Inference and Testimony require the use of *sentences*, we state the nature of a sentence,—which pertains to Grammar.

### Section VII.—Grammar.

#### *Aphorism LII.*

**A sentence is a particular sound, formed of the language of this or that**

country, which has the nature of a proposition, inasmuch as it is intended to communicate the relation between a subject and a predicate.

(1). But then a sentence is of *three* kinds, viz., a question, a command, and a proposition; why then do you say "which has the nature of a proposition"? We reply,—Nay,—for questions and commands may be resolved into propositions. For example, the question "Why have you come?"—is equivalent to the proposition "I wish to know the cause of your coming" So again the command "Go you away" is equivalent to the proposition "Your going away is what I wish."

(2). Thus all sentences, from their being intended to communicate the relation between a subject and a predicate, have the nature of propositions; and the words of which they are composed have different names in consequence of the difference of their functions in the proposition. To explain,—some words can denote subjects, others can predicates,—while some communicate the relation between the two;—others indicate the conjunction of the things meant by words and sentences,—others are in themselves equivalent to sentences. How this diversity of function gives occasion for a diversity in the names of words,—we proceed to remark.

*Aphorism LIII.*

Words are named in accordance with their functions.

(1). Let us show what names are given, in consequence of what functions, to what words.

(2). A word that, as we please, can signify either a subject or a predicate, is called a Noun;—as "cow," "Ḍittha," &c.

(3). A word that, as we please, can stand as a predicate, or as a *part* of a subject, is called an Adjective;—as "white," "moveable," &c.

(4). A word that, as we please, can form either a subject or a predicate,—but which varies its meaning with the person speaking,—is called a pronoun;—as "I," "thou," [and, according to the Sanskrit Grammarians,] "east," "south," "upper," "nether," &c.

(5). A word which expresses the relation of the predicate and subject, and also the predicate, is a verb;—as "sleeps," "goes," "stands," &c.

(6). The other words are without inflection. They are of three sorts, (1) conjunctions, (2) adverbs, and (3) interjections. Conjunctions are "and," &c. Adverbs are "slowly," "swiftly," &c. Interjections, which are equivalent to sentences, inasmuch at they express wonder, joy, grief, &c., are are "aha," "ah," "oh," &c.

(7). Now we state the origin of language.

*Aphorism LIV.*

The interjection is the root of the sentence.

(1). We mentioned (under Aph. 53, § 6) that an interjection, such as "Oh," is a sentence in itself, since it expresses surprise, joy, grief, &c., and it is this that is the root, or origin, of language. To explain. When a healthy child, unable, as it is a suckling, to speak, instinctively cries on being pained by hunger, then his mother, understanding the cry as a sign of hunger, gives him milk. This same crying is the earliest form of language. Though the interjections "ah," "oh," &c., are wholes, there is no mistaking the subject in the above example, since the object of the [healthy child's] wish can be but one thing; but where the wish might have more

than one subject, there the subject is not ascertained by a cry simply. For example, when a child somewhat older than a suckling cries in order to obtain something, then the object of his wish is not ascertained by the cry, but it is only understood that he wants *something*. Therefore, being offered food by his mother when he wants drink, or drink when he wants food, perceiving that his mother is not sure of the object of his desire, he indicates the desired object by his hand, or his look, &c. Here the thing which is pointed to is the subject of the proposition, and the desire is what is predicated. Even the lower animals can proceed thus far in the matter of language. For example, when a dog, looking at a bone or a piece of flesh in the hand of some one, wagging his tail, whines softly, then both his desire and its object are known. But there is this difference, that the lower animals make no further convention than this, while men can go much further; and thus in the case of the beasts there is but the commencement of language,—but among men it is gradually extended and improved.

(2). Here ends the section on Language.

(3). Having thus explained the nature of evidence, now with a view to setting forth what may be thereby arrived at, we proceed to enounce the things which it is desirable should be rightly known.

*Aphorism LV.*

Things which it is desirable should be rightly known are Number and Magnitude; Motion of the earth, &c.; its cause, viz., Force; Chemical affections; Physiological truths; Geology and Physical Geography; History; Political Economy; Ethics; and Natural Theology.

(1). These subjects are to be expounded, in the sequel of this work, in the above order of enunciation; and the reason for that is this. That which can be considered independently of the consideration of something else, is to be first set forth; and that which cannot be considered without reference to another subject, must be expounded subsequently thereto. For example, since Number and Magnitude, are common to all bodies, they are not dependent on the consideration of Motion, Force, Chemical affections, &c.; therefore they are expounded antecedently to these. In the consideration of Motion, Force, &c., on the other hand, the consideration of Number, is pre-supposed; therefore their exposition takes place subsequently to that of Number;—and so of the rest.

(2). Here ends the second Book of the Synopsis of Science,—the investigation of the nature of Evidence.

A

# SYNOPSIS OF SCIENCE.

## BOOK III.

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MATHEMATICS AND FORMAL ASTRONOMY.

## INTRODUCTION.

(1). Now we shall consider Number and Magnitude, which stand first in the list of topics at the end of the preceding Book, and also the Motion, thereby measured, of the earth, &c.

(2). In the science of calculation, that branch which treats of determinate numbers is called Arithmetic.

### SECTION I —ARITHMETIC AND LOGARITHMS

(3). The following is probably what suggested the employment of the decimal notation.

*Aphorism I.*

Numbers are made to increase by tens probably because men have ten fingers.

(1). On looking at an assemblage of objects,—say of men,—if the spectator wishes to ascertain or to remember the number, he may use his fingers as the means of notation. Let him hold up a finger for each man, and give a name, "one," "two," "three," and so on, to each finger. When he has come to the last finger, he must begin a new set, and he must note in some way how many sets there were in all. It is probable that this was the origin of the method of notation in general use, where the values of the figures, in the successive places, increase by tens. If men had had twelve fingers, the values of the figures would probably have been made to increase by twelves.

(2). The rules for calculation derived from this science may be learned from Bápú Deva's treatises.

(3). The ordinary rules of computation are inconvenient when we have to deal with very large numbers. In such cases we may make use of the method of *Logarithms,* some account of which here follows.

*Aphorism II.*

By means of Logarithms the processes of multiplication and division can be reduced to those of addition and subtraction; and involution and the

extraction of roots can be effected by a single multiplication or division.

(1). Take a set of numbers, each number exceeding the number preceding it by a given difference, and let the first number in the set be equal to the given difference; as 1, 2, 3, 4, 5. &c., where the difference is 1. Then take another set of numbers such that each is equal to twice or thrice or any fixed number of times the one before it, the first number in the set being equal to the multiplier, as 10, 100, 1000, 10000, &c., where the multiplier is 10. Write the second set of numbers under the first set thus

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 10, | 100, | 1000, | 10000, | 100000, | 1000000, | 10000000. |

then the numbers in the upper line will be the Logarithms of those in the lower, and the facts asserted in the Aphorism will be found true as follows.

(2). Take the sum of two of the numbers in the upper line, and there will be found in the lower line opposite that sum the product of the numbers which stand in the lower line opposite to the numbers the sum of which was taken. For example, of the two numbers 2 and 4 in the upper line, the sum is 6; and under 6 is found the number 1000000; and this is equal to the product of the numbers 100 and 10000, which stand beneath 2 and 4.

(3). Again, if you take the difference of two numbers standing in the upper line, then you will find in the lower line, opposite that difference, the quotient which arises by dividing the greater by the lesser of the numbers standing under those the difference of which was taken. For example, the difference of 6 and 4 is 2, and under 2 you will find 100, which is the quotient of 1000000 divided by 10000, the two numbers standing under 6 and 4.

(4). Again, if you multiply or divide, by any number, one of the numbers in the upper line, then you will find, under the number thus obtained, the corresponding power or root of the number standing under the number multiplied or divided. For example, multiply by 3 the number 2 in the upper line, and under the product, 6, you will find 1000000, which is the third power of 100, the number standing under 2.

(5). The logarithms of all the numbers from 1 up to many thousands have been calculated and arranged in tables, from which the logarithm of any particular number can be readily ascertained.

*Aphorism III.*

Symbols of processes are employed for shortness.

(1). That is to say, certain signs are employed in order to make the language of Arithmetic shorter. A cross placed between two numbers signifies that they are to be added together. Thus $2+4$ means that 4 is to be added to 2.

(2). Two parallel lines signify equality. Thus $2+4=6$ means that 4 added to 2 is equal to 6.

(3). A single line between two numbers signifies that the latter is to be subtracted from the former. Thus $6-2=4$, i. e., six diminished by 2, is equal to 4; and it is clear that no number except 6, diminished by 2, can be equal to 4.

(4). It often however becomes necessary to speak of something which is true, not of any one number only, but of all numbers. For example, take 5 and 2; their sum is 7, their difference is 3. If this sum and difference be added together, we get 10, which is twice the greater of the two numbers first chosen. If from the sum we subtract the difference, we get 4, which is twice the lesser of the two numbers. The same thing will be found to be true of any two numbers.

(5). Hence if we have two sealed bags of rupees, the one containing a large number, and the other containing a small number, both numbers being unknown to us, we can assert with certainty that the sum of the rupees in both bags, added to the difference between the two, is equal to twice the number of rupees contained in the larger bag; and that the sum, diminished by the difference, is equal to twice the number of rupees in the smaller bag.

(6). Taking the letter $a$ to represent the unknown number of rupees in the larger bag, and $b$ to represent the unknown number in the smaller bag, we can assert that—

$$(a+b)+(a-b)=2a, \text{ and } (a+b)-(a-b)=2b.$$

(7). Such an employment of letters to denote quantities respecting which we can make assertions without knowing what the quantities are, has given rise to the science of Algebra.

## SECTION II.—ALGEBRA.

### *Aphorism IV.*

In Algebraical calculations the results are not particular but general.

(1). In addition to the symbols already mentioned, the following are constantly employed in algebraical notation. A cross placed diagonally between two numbers signifies that they are to be multiplied together. Thus $a\times b$ means that the number denoted by $a$, whatever number it may be, is to be multiplied by the number which $b$ stands for. This may be also represented by writing the letters together, thus $ab$. If $a=2$, and $b=3$, then $ab=6$.

(2). When two letters are written, the one above a line and the other below it, it is signified that the upper is to be divided by the lower. Thus if $a=6$, and $b=2$, then $\frac{a}{b}=3$.

(3). A number multiplied by itself, thus $aa$, is written thus $a^2$. This is called the square of $a$.

(4). If again multiplied by itself thus $aaa$, it is written thus $a^3$. This is called the cube of $a$.

(5). The small figure written above the letter is called the index.

### *Aphorism V.*

As the results of Algebraical operations are general, they furnish arithmetical rules.

(1). For example:—when there are four numbers, the first of which contains the second exactly as many times as the third contains the fourth, the four numbers are said to be in proportion. For example, let the four numbers be represented by $a$ $b$ $c$ and $d$; if $a$ contains $b$ exactly as many

times as $c$ contains $d$, then $a$ $b$ $c$ $d$ are in proportion. Suppose that $a$ contains $b$ three times, then $\frac{a}{b}=3$, and also $\frac{c}{d}=3$; and, as things that are equal to the same thing are equal to one another, $\frac{a}{b}=\frac{c}{d}$.

(2). Again, as the equimultiples of equals are equal, multiplying each by $bd$, we get $ad=bc$; that is to say, the product of the first and fourth, out of four numbers in proportion, is equal to the product of the second and third. This is the foundation of the very useful rule called the Rule of Three. In the Rule of Three, the first three terms of a proportion are given, and we are required to find the fourth. After determining the order of the terms from the conditions of the question, we multiply together the second and third. The product, we know, is the same as the product of the first and fourth, so that, in order to find the fourth, we have only to divide the product by the first term.

*Aphorism VI.*

The application of algebraical processes enables us to make discoveries respecting the properties of form such as would have been otherwise beyond our reach.

(1). We shall briefly indicate the way in which this application is made. Suppose that we call an inch *one*,—then a line of two inches will be represented by 2, a line of eight inches by 8, and a line of as many inches as are signified by the letter $a$ will be represented by $a$. In like manner surfaces such as a parallelogram, and solids, such as a cube, can be represented by letters; and by performing algebraical operations on these symbols, new properties of the magnitudes are deduced.

(2). There are some relations of form however which cannot be determined by the use of signs representing numbers. For example, the relation of the angles at the base of an isosceles triangle. Such relations of magnitude must be studied by the aid of lines, straight or curved; and this branch of the science of Quantity is entitled Geometry.

## Section III.—Geometry.

(3). Here a leading distinction among lines requires to be noticed at the outset.

*Aphorism VII.*

A straight line is one which never changes its direction. A curve line is one which continually changes its direction, so that no two successive points in it are in a straight line.

(1). Hence if a point in a curve coincides with a point in a straight line, it is impossible that the next points should coincide.

(2). In the Elements of Euclid, the text-book of elementary Geometry, which has been published in Sanskrit by Pandit Bápú Deva, the only curve line admitted is the circumference of the circle.

(3). The postulate on which Euclid's reasonings are based is this, that two figures are equal, the one of which either exactly covers the other, or can be divided into portions which, all taken together, will exactly cover it,

(4). Thus, in the fourth proposition of his first book, he infers that two triangles are equal which have two sides and the contained angles respectively equal, because the one triangle, if laid upon the other, must exactly cover it.

(5). But here a difficulty arose. We have already explained that if a point in a curve coincide with a point in straight line, the next points in the two lines cannot possibly coincide. Hence when we come to compare surfaces bounded by straight lines with surfaces bounded by curved lines, we may go on for ever sub-dividing the one or the other without being able to bring about a coincidence of their boundaries.

(6). As it was of great importance to the advancement of Astronomy and other sciences dependent upon the aid of Mathematics, that we should be enabled to carry out the comparison of rectilinear with curvilinear surfaces and solids to any degree of nicety which might be required, various ingenious methods were invented during the two thousand years between the time of Euclid and the time of Newton.

(7). That which has superseded all the rest, the method of Newton, improved by the notation of the German philosopher Leibnitz, is called the Differential and Integral Calculus.

### Section IV.—The Differential and Integral Calculus.

(8). In the *Lílávatí* of Bháskara Áchárya, the following question is proposed. A peacock seated on the top of a pillar sees at some distance a snake, which tenants a hole at the foot of the pillar. The snake, at the sight of its enemy, makes for its hole, and at the same instant the peacock flies down in pursuit of it. The height of the pillar being given, and the distance of the snake from the foot of it, and also the comparative speed of the two animals, it is required to determine the point at which the peacock will pounce upon the snake.—Now this question cannot be solved without the aid of the Calculus. Bháskara Áchárya, perceiving that there is a point at which the peacock will meet the snake if he fly down in a straight line, assumes that he will fly in a straight line, and proceeds to deduce the consequences of the supposition. But if the peacock be not such a mathematician as to know this point, he will direct his flight continually towards the snake, and as the snake is continually changing its place, the direction of the peacock's flight will continually change, and this, as previously stated, is the characteristic of a curved line. The determination of the curve in question involves processes intelligible only to those who have attained to some proficiency in the study of the Calculus.

(9). The solution of the following simpler case may be rendered intelligible to one who understands at least the common rules of Algebra.

(10). It has been ascertained by experiment that a body dropped from a height falls towards the earth through rather more than 16 feet in the first second, four times as much, or 64 feet, in two seconds, nine times as much, or 144 feet, in three seconds, and so on,—the space increasing according to the square of the time. A very little consideration of this fact must make it apparent that the rate of falling never continues uniform for even the smallest assignable portion of time; else, why should the rate, after having been uniform for any period, become changed without the intervention of a new cause? Now the rate of motion is always estimated by the distance gone over by some assumed uniform motion, in a given time; and suppose

we wish to know the rate at which the body was falling exactly at the end of the third second. The rate must be something greater than it was immediately before, and something less than it was immediately afterwards. We must here premise the first proposition of Newton's *Principia*, which is as follows.

*Aphorism VIII.*

"Quantities which tend towards equality, and of which the difference, in the course of this approach, becomes less than any finite magnitude that can be assigned, must be ultimately equal."

(1). "If this be denied, let them ultimately differ by a magnitude denoted by D. Then the difference between them cannot become less than this finite magnitude D, which is contrary to the hypothesis."

(2). Now let us call 16 feet a *measure*; then the number of measures through which the stone falls in $x$ seconds is $x^2$. Let us next suppose a very small portion of time $h$, and let the position of the stone, which fell from the point O, be A at the end of $x$ seconds, B at the end of $x+h$ seconds, C at the end of $x+2h$ seconds, &c. Then the values of the lines, expressed in measures, are as follows:—

$$OA=x^2,\ OB=(x+h)^2,\ OC=(x+2h)^2,\ \&c.$$

Whence

$$AB=OB-OA=2xh+h^2=(2x+h)\,h$$
$$BC=OC-OB=2xh+3h^2=(2x+3h)\,h$$
$$CD=OD-OC=2xh+5h^2=(2x+5h)\,h,\ \&c.$$

—O
—A
—B
—C
—D

(3). From this we see that in the successive small portions of time denoted by $h$ the spaces traversed were in the ratio of $2x\times h, 2x\times 3h, 2x\times 5h$, &c.

(4). Since, the greater the space fallen through, the greater is the change of the rate, it follows that the smaller the space fallen through, the smaller is the change of the rate; or in other words the nearer does the rate approach to the condition of uniform motion.

(5). The smaller then we suppose $h$ to be, the more nearly will the foregoing expressions denote the uniform rate of motion at a given instant; and, according to the proposition quoted above, the expressions must ultimately coincide with the expression which we are in search of, if we carry the diminution of $h$ to its extreme limit, or make it equal to *nothing*.

(6). Now when $h$ is made equal to nothing, all the above expressions become $2x$. So we find that the rate, at the end of any number of seconds, is twice that number of measures.

(7). At the end therefore of three seconds when $x=3$, the stone, had its motion suddenly become uniform, would have passed, in the course of the next second, through 96 feet; for $2\times3\times16=96$; whereas, in consequence of its continual acceleration, it actually passes through 112 feet.

(8). The line OA, the length of which is here supposed to vary by successive additions, is called a variable quantity.

(9). Variable quantities, in this branch of enquiry, are represented by the letters $x\ y\ z$.

(10) The portions A B, B C, C D, by which the successive values of the variable differ from each other, and which may be supposed indefinitely small, are called differentials.

(11). The differential of $x$ is written thus $dx$; and, in like manner, those of $y$ and $z$ $dy$ and $dz$.

(12). The question which has been worked out above, would be proposed in the Differential Calculus in the following shape. "If $x$ vary uniformly, at what rate will $x^2$ vary?" We have seen that it will vary $2\,x$ times as fast; so that if the differential of $x$ be $dx$ that of $x^2$ is $2xdx$.

(13). By comparing $2xdx$ with $x^2$, we arrive at the first rule for differentiating, viz. "Multiply by the index, diminish the index by unity, and multiply by the differential of the variable."

(14) The following are examples of differentiation;—$d.\,x^3$, that is to say the differential of the cube of $x$, is equal to $3x^2dx$; and again, $d\,ax^4 = 4ax^3\,dx$.

(15). The coefficient, or multiplier, of $dx$ in these expressions is called the *differential coefficient.*—Thus, in $4ax^3dx$, the differential coefficient is $4ax^3$.

(16). When the value of a quantity depends upon the particular value of another variable quantity, the one quantity is said to be a *function* of the other.

(17). Thus, the area of a square, depending on the length of its side, is said to be a *function of the side.*

(18). The aim of the Differential Calculus is to determine the differential of any given function.

(19). The aim of the Integral Calculus is the converse of this, viz. to ascertain the function from which a given differential has been derived.

(20). The first rule for integration is therefore the converse of that for differentiating.—viz. "Add one to the index, divide by the index thus increased, and by the differential of the variable."

(21). By thus treating the differential $2xdx$ we recover the function $x^2$.

(22). The symbol of integration [or summation] is a long shaped $s$,—thus $\int 2xdx = x^2$.

(23). Thus is the section on Number and Magnitude completed. Now we have to consider, as next in order presenting itself, the Motion, measured thereby, of the Globe of the Earth, &c In the first place we have to state the name of the science which has this for its object-matter.

## SECTION V.—FORMAL ASTRONOMY.

### *Aphorism I.*

The science which expounds the Motions, regulated by Number and Magnitude, of the Globe of the Earth, &c., is called Astronomy.

(1). Here by the "&c.", we mean the planets, comets, and stars. Of these, the Sun and stars shine by their own light, but the planets and comets are opaque bodies and they shine by the light of the Sun. Hence, as the moon changes her phases, so, we learn by the aid of the telescope, do others, e. g., Venus.

(2). We state the form of the Earth.

### *Aphorism II.*

The Earth is globular.

(1). A man on a cursory view supposes that the Earth is infinitely spread out all around; but, considering that the Sun Moon and stars, setting daily in the West, rise again undisturbedly in the East, he must soon

infer that the Earth is not an infinite, but a finite mass, and that it abides in the heavens without any material support. As Bháskaráchárya puts it, "On seeing the revolution of the constellations, we become aware that the Earth is without any material support."

(2). It being thus proved that the Earth is finite, it can be proved that the form of it is globular. A man standing in the equatorial regions, observes the constellations moving vertically towards the west, while the poles rest on the horizon. As he advances towards the north, he observes the constellations gradually declining towards the south from his zenith, and the north pole rising above the horizon. Bháskaráchárya thus gives his opinion to the same effect. "In the equatorial regions, a man sees the north and "south poles in the horizon, and the constellations, resting on the poles, "revolving in the heavens at his zenith like a water wheel. As he advances "towards the north, he observes the constellations declining from his zenith "and the north pole rising above the horizon."

(3). Thus, as the said observation cannot be accounted for without the circularity of the Earth towards the south and north, the form of the Earth is proved to be circular in those directions. And a man standing on an open plane sees from a distance the upper part of an object such as a house &c., but the more he approaches the object, the more he sees of the lower part of it. This fact cannot be accounted for without supposing that the Earth is circular in every direction. Hence the ancients have affirmed that the Earth is globular.

(4). As the determination of magnitude depends on form, having therefore declared the form of the Earth, we proceed to state its magnitude.

*Aphorism III.*

The diameter of the Earth is in length 7900 miles.

(1). The method given by Bháskaráchárya for finding the circumference of the Earth is as follows. Find the degrees of latitude of a city, and also that of another city due north of it; take the difference in degrees between these two latitudes, and find then the fourth proportional to this number of degrees, the distance between the cities in miles, and 360 degrees. The result is the number of miles in the circumference of the Earth. Thus the modern European Astronomers have ascertained, by a method which involves the principle just mentioned, that there are 24,820 miles in the circumference of the Earth.

(2). The circumference and consequently the diameter of the Earth being thus known, it is easy to ascertain the distance of the nearest heavenly bodies, and their magnitude &c., by the aid of the parallax. We proceed therefore to define the term parallax.

*Aphorism IV.*

Parallax is the difference between the two positions of an object caused by the difference between two positions of the observer.

(1). For instance, the line of sight of a man seated and observing the top of a pillar upright before him, falls on a wall at a point higher than the pillar; and that of the same man standing up will of-course fall on the wall below the former place. The distance between the two places where the former and the latter lines fell is called the parallax. So again an observer on the surface of the Earth sees a heavenly body, when not in the zenith,

below the place where an observer at the centre of the Earth would see it. The difference, in the concave of the heavens, between these two places, is called the parallax of that heavenly body. There is no parallax when the heavenly body is in the zenith. The further it recedes from the zenith towards the horizon, the greater is the parallax, till the body reaches the horizon, where the parallax attains its extreme limit.

(2). Now, the distance of any heavenly body from the centre of the Earth can be found by multiplying the radius of the Earth by the [trigonometrical] Radius, and dividing it by the sine of the horizontal parallax of that body; or the sine of the horizontal parallax can be found by dividing the radius of the Earth by the distance. This operation is grounded on the rules of Plane Trigonometry.

(3). Having thus explained the meaning of the term parallax, we shall enounce the horizontal parallax and the distance first of the Moon.

*Aphorism V.*

The horizontal parallax of the Moon is something more than 57′ 4″; and the Moon's distance is 237,000 miles.

(1). That this is the distance of the Moon from the centre of the earth can be easily found when we have determined the horizontal parallax. But it is difficult to find the parallax by the way just mentioned, because, no observer can go to the centre of the earth. For this reason, we are obliged to find the parallax by another method.

(2). Suppose there are two places, remote from each other, one in the northern hemisphere and the other in the southern, under the same meridian, the latitude of both being known. Spectators situated at these two places would see the zenith distance of the Moon at the same time when she came to their meridian. Now, in the quadrilateral figure described by the two radii of the earth at the spectators' places, and the two vision-lines from the spectators to the Moon, the angle contained by the radii is known, because, it is equal to the sum of the latitudes of the two places, and also the two angles contained by the radii and the vision-lines are known, since each of them is equal to 180° diminished by the zenith distance. The two sides which are the radii at the spectators' places are also known. The vertical diagonal which can be now easily found by the rules of Trigonometry, is the distance of the Moon. The distance of the Moon thus found by daily observation, till the completion of its revolution, is found to vary. Therefore having marked the different distances round the centre of the earth, draw a line joining these marks, and this, which is the true path of the Moon, will have the form of an ellipse. The mean distance of the Moon from the centre of the earth, calculated from its true path just mentioned, is equal to 237,000 miles, and its horizontal parallax, deduced from its distance, is equal to 57′ 4·17″.

(3). Now, a knowledge of the *magnitude* of the heavenly bodies being dependent on that of their distance and the horizontal parallax, having declared these in regard to the Moon, we proceed to speak of its magnitude.

*Aphorism VI.*

The diameter of the Moon is equal to 2154 miles.

(1). By the aid of the horizontal parallax of the Moon, it is easy to

find its diameter. It is evident that the diameter of the Moon must be the same part of the diameter of the earth, that the disc of the Moon in minutes seen from the earth is of that of the earth in minutes seen from the Moon. The mean minutes in the disc of the Moon are equal to 31, and the whole disc of the earth seen at the Moon would be equal to twice the number of minutes in the horizontal parallax of the Moon. Therefore by taking twice the minutes in the horizontal parallax of the Moon, the diameter of the earth, and the minutes in the disc of Moon, and finding a fourth proportional to these, it can be proved that the diameter of the Moon is equal to three elevenths of the diameter of the earth. Thus we know that the mass of the Moon is equal to the forty-ninth part of that of the earth.

(2). Having thus declared the horizontal parallax, the distance, and the magnitude of the Moon, we now proceed to declare the horizontal parallax and the distance of the Sun.

*Aphorism VII*

The horizontal parallax of the Sun is something more than 8·6″, and its distance 95,000,000 miles.

(1). The method before mentioned for finding the distance and the parallax of the Moon, though correct in principle, is not available for finding those of the Sun, because a slight difference in the degrees of the zenith distance determined by observation would cause a very great difference in the distance of the Sun as determined by this method, in consequence of the very great distance of the Sun. For this reason, Astronomers determine the parallax of the Sun by means of the time which Venus takes in traversing the Sun's disc. The method is as follows.

(2). When Venus is in inferior conjunction, and her latitude is very small, at that time men observe her as a black disc, on the Sun's disc. Now if two spectators situated at the two extremities of the diameter of the earth perpendicular to the ecliptic plane, see Venus at the same time, each of them would see her in a different place on the Sun's disc. Now, the fourth proportional in the case of the distance between Venus and the Earth, the Earth's diameter, and the distance between Venus and the Sun, is the space between the two marks on the Sun's disc where Venus is seen by the spectators. Therefore, this space is two and a half times greater than the diameter of the Earth, and consequently five times greater than the radius, because the distance between Venus and the Sun is so much greater than the distance between the Earth and Venus. From this it follows that spectators situated at the Sun would see in the heavens the half of the Earth's disc in minutes equal to the fifth part of the distance in minutes between the two marks of Venus on the Sun's disc. This is the horizontal parallax of the Sun, and therefore the 5th part of the minutes of the distance between the marks of Venus on the Sun's disc would be the exact horizontal parallax of the Sun. We now therefore proceed to give the method for finding the minutes of the distance in question.

(3). Let each observer, having most carefully ascertained the time at which he would see the centre of Venus immersed after its entering the Sun's disc, and having determined the true motion of the Sun and the retarded motion of Venus, ascertain the space in minutes passed by the relative motion of Venus in the determined time. The space will be in the form of a chord in the disc of the Sun. Now, the minutes in the disc of

the Sun are already known. Through these minutes, find the versed sines of those chords, and the minutes which you will find in the difference of these versed sines, are the minutes in the distance between those chords. These are the minutes in the distance between the two spots of Venus. Thus the distance between the two spots being known, the fifth part of it, namely 8.″5776 is the exact horizontal parallax of the Sun. Through this same method we can determine the exact horizontal parallax of the Moon, by observing the time which she takes in causing the occultation of any star. The parallax of the Sun being known, it is easy to find his distance [viz, 95,000,000 miles] by the aid of the method already mentioned.

(4) Now, being led by curiosity to inquire what is the magnitude of the Sun which, though situated at such an immense distance, yet influences us by its great heat and light, we declare its magnitude.

*Aphorism VIII.*

The diameter of the Sun is 882,000 miles.

(1). By the aid of the micrometer, we get the mean magnitude of the disc of the Sun equal to 32′.29″. Now, it is proved by an easy calculation of Trigonometry that an object which, standing at a distance of 95,000,000 miles, seems to be equal to 32′.29″ must possess the breadth of 882,000 miles. Hence the diameter of the Sun is as given above; and thus modern astronomers have ascertained that the Sun is 1,400,000 times greater than the globe of the earth.

(2). A visible displacement of the Sun and Moon is caused by a distance between observers equal to the diameter of the earth; but no alteration is caused in the visible places of the fixed stars by the same distance. Now, if the earth revolved round the Sun, there might be a possibility of noticing an alteration in the places of the stars, because the distance between the places of observation would then be very great, being equal to the diameter of the orbit of the earth which is equal to twice the distance of the Sun from the earth, or 190,000,000 miles. Let us first then speak of the earth's revolution.

*Aphorism IX.*

The earth, turning upon its axis in a day and night, performs one circuit round the Sun in the course of a year.

(1). Men imagine that they daily observe the Sun Moon and stars revolving round the earth, but this is their error,—like the boys who erroneously think they see the bank of a river move. As *Árya Bhaṭṭa* says—

" An observer at the equator sees the fixed stars move to the west, as " a man in a boat observes the fixed things moving backwards while he goes " forward."

(2). Though, by the supposed revolution of the Sun, his passing through all the signs of the zodiac in a year may be accounted for, yet it can be proved by the aid of Dynamics, as will be shown under that head, that it is the earth that revolves round the Sun.

(3). The revolution of the earth about the Sun being settled, we are led to enquire around what the other planets revolve; and we state as follows.

*Aphorism X.*

The other planets also in like manner revolve about the Sun.

(1). As the earth revolves about the Sun, so the other planets, Mercury, Venus, &c., revolve about him. Among these the planet Mercury, which is nearest to the Sun and possesses a diameter of 2950 miles, revolves at the distance of 36,770,000 miles from the Sun. Next beyond it, the planet Venus, possessing a diameter of 7700 miles, revolves at the distance 68,710,000 miles from the Sun. The earth comes next, revolving at the distance of 95,000,000 miles. Next in order the planet Mars, possessing a diameter of 4100 miles, revolves at the distance of 144,750,000 miles from the Sun. Modern astronomers have discovered 21 small planets revolving between Mars and the next great planet Jupiter. Beyond these small planets, Jupiter, having a diameter of 88,610 miles, revolves at the distance of 494,270,000 miles; and the planet Saturn, whose diameter is 75,000 miles, revolves at the distance of 906,190,000 miles, from the Sun. Saturn is surrounded by a large ring divided into two parts, which, however, cannot be seen without a telescope. After this, a planet, possessing a diameter of 34,500 miles, revolves at the distance of 1,822,330,000 miles. This planet, being discovered by the astronomer Sir W. Herschel, is called Herschel, after its discoverer. Beyond this, the planet Neptune, whose diameter is 37,500 miles, and which has been lately discovered, revolves at the distance of 2,854,000,000 miles from the Sun. Formerly only seven planets were known, but now twenty-nine heavenly bodies are reckoned as planets. Many comets also circulate round the Sun in very elliptical orbits.

(2). If it be asked about what the Moon revolves, which seems entitled to the name of a planet, but which we have not reckoned amongst the planets, we reply.

*Aphorism XI.*

The Moon revolves about the earth, and for this reason it is called a satellite.

(1). As the planets Mercury &c. revolve round the Sun, so the Moon revolves round the earth. Now, modern astronomers technically give the name of planet to those in the centre of whose orbits is the Sun, and the name of satellite to those in the centre of whose orbits is a planet.

(2). As the earth has one satellite, let us enquire how many satellites, if any, the other planets have; and here we have to state as follows.

*Aphorism XII.*

Jupiter has four satellites, Saturn eight, Herschel six, and Neptune one.

(1). So much for the established fact that all the planets with their satellites circulate round the Sun.

(2). The revolution of the earth round the Sun being established, we state what may be inferred, regarding the distances of the fixed stars, from a consideration of the distance between observers at opposite extremes of the diameter of the earth's orbit.

*Aphorism XIII.*

The fixed stars are at a distance of more than twenty billions of miles from the Sun and the earth.

(1). Had the parallax of any star been obtained equal to 1″ it would have proved that the star is at the distance of 20 billions of miles; but the parallax of none of the stars is found equal to even 1″. Therefore the distance of the stars from the Sun and the earth is more than 20 billions of miles. Since Light, as will be proved afterwards, travels at the rate of 192,000 miles per second, it follows that the light issuing from the fixed stars reaches the earth after more than three years. Hence we infer that the fixed star which we see now in any given place came to that place more than three years ago.

(2). The following are other inferences.

*Aphorism XIV.*

The fixed stars shine like our Sun; some of them are as large as he is, and others larger and some smaller. As we see them like points, so our Sun must appear, if viewed from there, of the same size; and as the distance of the nearest star from the Sun is 20 billions of miles, the distance of the innumerable stars from each other may possibly exceed twenty billions of miles. The Milky Way which we see in the heavens is only the light of a multitude of fixed stars.

(1). They are "innumerable". The number that we see with the naked eye, can be reckoned; but those which become visible by the aid of the telescope are innumerable. The astronomer Sir W. Herschel, with his telescope, observed more than 5000 stars in the space of a square degree.

(2). Here ends the Third Book of the Synopsis of Science,—the consideration of Number, Magnitude, and Motion.

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# A
# SYNOPSIS OF SCIENCE.
## BOOK IV.

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### Mechanics.

#### Section I.—Of the causes of Motion and Rest.

(1). Having, in the Third Book, considered actually existent Motions, intending now to set forth the *causes* of Motion and Rest, we state the name of the cause of Motion.

*Aphorism I.*

The cause of Motion is called Force.

(1). Next we state where this Force is lodged.

*Aphorism II.*

Force is lodged in Atoms, and in the Masses formed of these.

(1). *Atoms?* All the perceptible things in the world are made up of parts. Among those parts, some [—viz., those which are unsusceptible of division—] are extremely minute, and are indestructible by human power. A piece of iron, for example, though a thousand times bruised, broken, melted by fire, or otherwise altered, can again, by the reassembling of the separate parts, be exhibited just as before. These most minute parts are called Atoms.

(2). Now we state the varieties of Force which belong to Atoms and to the Masses formed of these.

*Aphorism III.*

They have three kinds of Force, viz., Attraction, Repulsion, and Inertia.

(1). "They",—i.e., Atoms and the Masses formed of them.

(2). *Attraction?* It is found that the Atoms, whether separate or already joined into Masses, tend towards all other atoms or masses,—as when the atoms of any mass, such as a stone, are held together [by some influence which we know only by its effects] with a certain force; or when a block of stone is similarly held down to the earth on which it lies; or when the sea [in the flow of the tide] rises towards the moon. Let the cause of these effects be called *Attraction.*

(3). *Repulsion?* Atoms, under certain circumstances,—for example when Heat is diffused among them,—have their mutual attraction resisted, and they tend to separate,—as when ice heated melts into water, or when water heated expands into steam. Let the [Force which is the] cause of these effects be called *Repulsion.*

(4). *Inertia?* As a potter's wheel, when made to revolve, at first offers resistance to the force moving it, but gradually acquires speed proportioned to that force, and then resists being again stopped—in proportion to its speed, so all bodies and atoms appear to have, in regard to motion or rest, a *stubbornness,* [or power of resistance], tending to keep them in their existing state whether of motion or of rest. Let this property be called *Inertia.*

(5). Now we have to see how the enquiry into Atoms and their mutual Attraction, &c., is to throw light on the nature of the material universe; and we proceed in the first place to declare as follows.

*Aphorism IV.*

The sensible universe is formed of Atoms.

(1). As before mentioned, a piece of metal, after having been bruised and broken and dissolved and altered in a thousand ways, can be always recovered as perfect as at first. Although this is not the case with things that are organized,—as the leaves of trees or the feathers of birds,—for we cannot restore to an organized structure the form that it had before,—yet, as we shall see when we come to the subject of Chemistry, even when these are burned, not a single Atom is really lost.

(2). Now we proceed to set forth the extreme minuteness of Atoms.

*Aphorism V.*

Atoms are inconceivably minute.

(1). Gold leaves can be made so thin by hammering, that 360,000, laid one upon another, produce the thickness of a single inch. Even in this state also the leaves are quite perfect and free from holes, because one of them, laid upon any body, as in gilding, makes the body appear as a golden thing. Still thinner than this is the gold-coating of silver wires &c.; but still it cannot be proved that this thinness is equal to that of an atom. If the wire be placed in nitric acid, the silver is dissolved by the acid, and the gold coating remains like a golden tube.

(2). The followers of the Nyáya hold that the magnitude of an Atom is smaller than any magnitude [or positively small], so that the magnitude of an Atom is no element in the magnitude of a combination of two Atoms, because that which is produced from [the intensifying of] the small ought to be still smaller [—as in the multiplication of fractions by fractions,—or in the summation—as regards the positive result—of minus quantities in Algebra]. We on the other hand [for the most part] hold, that, although they may be exceedingly small in comparison with the masses formed of them, yet there is no reason why they should not possess a determinate bulk with reference to these,—so that the bulk of two Atoms may be twice the bulk of one.

(3). A European philosopher, of the name of Boscovich, put forward a theory that Atoms have no magnitude, and that they differ from mathematical points only inasmuch as they have force [—in the shape of a repulsion which secures to each atom its own range]. Although this hypo-

thesis is not devoid of plausibility, yet it does not serve so well to explain the varied phenomena of the material universe as the hypothesis followed in the present work.

(4). If it be asked,—why assert that Atoms occupy space, if they be so inconceivably minute?—we declare as follows:—

*Aphorism VI.*

Bodies always occupy space.

(1) Bodies occupying a large space, such as a large mass of cotton, &c., can be forced into a small space, but they cannot be so compressed as to occupy no space at all. This property of never ceasing to possess magnitude is called the Impenetrability of Matter,—a term implying that two bodies cannot occupy exactly one and the same place at the same time. If a glass tube, the bottom of which is open and the top closed by the thumb, be pressed into water, the water does not enter so as to fill it, because the air in the tube does not so give way to the water; but when the air is allowed to escape by removing the thumb, the water, in the absence of the air, fills the tube to the level of the water around it. In the same way water does not enter so as to fill any close vessel forced into it with the mouth downwards. A lighted taper floats and burns under a vessel though pressed very deep into water with its mouth downwards, on account of the presence of air there. Another example of this fact is, that a man can sustain his life under a diving bell.

(2). The particular force called Attraction is next to be defined.

*Aphorism VII.*

The force that leads to the conjunction of Atoms is called Attraction.

(1). That is to say,—an Atom, or a mass, tends towards another Atom or mass.

(2). The particles of a stone &c. cohere.

(3). A stone without any support rests only on its reaching the Earth.

(4). Logs of wood, ships &c., floating in calm water, gradually approach each other, and remain in contact.

(5). As men, villages, towns &c., stand in India, so do they on the side of the globe opposite to India; and plummets also hang there towards the centre of the Earth. But people there, like the reflection of a man in water, stand with their feet towards us. *Bháskarácháryа* in his *Goládhyáya* illustrates this as follows. "This [globe of the Earth] is covered on every part with multitudes of mountains, groves, towns, and monuments, as is the ball of the Nauclea's flower with its multitudes of anthers. Each man, wherever he stands, regards the Earth as being under him, and himself as standing upon it:—therefore those that stand at the distance of a fourth part of the circumference from one another mutually regard one another as standing horizontally, and those that stand in the opposite hemisphere as having their heads downmost [and forming antipodes], like the man and his reflected image at the margin of a piece of water;—and thus those who are [as regards our own position] placed horizontally or topsyturvy stand there just as we do here."

(6). It is in consequence of all the parts mutually attracting and so tending to a common centre that the Earth is spherical.

(7). In like manner when particles of mist coalesce into drops, those

(8). Melted lead, allowed to rain down from an elevated sieve, by cooling as it descends, retains the form of its liquid drops. It is in this way that the spherical small-shot used by sportsmen is made.

(9). Solid masses, dropped even from an elevated place, do not assume a spherical form; but those in a fluid state, assume it invariably. Hence we are led to conjecture that the Earth, the Moon, the Sun, and the planets, all of which are spherical, must at some time have been to a certain degree in a fluid state.

(10). But it may be asked,—if all things, being attracted towards the centre of the Earth, tend to it, why does it appear that smoke ascends? Because it is constrained. Smoke does not of its own accord ascend; but in reality the air near the Earth, being heavier, sinks below it and forces it to rise, just as water causes a straw to rise which has been thrust to the bottom of it.

(11). The Moon, though 240,000 miles distant from the Earth, raises, by her attraction, the water of the ocean under her, and thus occasions what is called the *tide*. The Sun, still further off, has a similar influence. For this reason, when the sun and moon act in the same line of direction [as they do twice in each month], the tide is greater [and is then called a spring-tide].

(12). Now we proceed to remark, that, though attraction acts even at the greatest distances, yet it diminishes by distance.

*Aphorism VIII.*

The attraction is greater the nearer the bodies are to each other, as the light of a lamp is more intense nearer the lamp than at a distance.

(1). "Nearer the lamp" &c. As a lamp placed in the middle of a box, made of four boards of a foot square, illuminates it,—so when it is placed in the middle of a box made of four boards of *two* feet square, it illuminates that also. But as the sides of the second box contain four times as much surface as those of the former, the light shines with only one fourth of the intensity on each square foot of the second box,—the space equal to the surface of each side in the former box. For this reason the second box is not so brightly illuminated as the former one. And, similarly, the less do they attract each other, the greater the distance of bodies from each other, in the same proportion as in the illumination of bodies by the lamp. And consequently, if the attraction of one body for another at a certain distance be represented by unity, the attraction, when the bodies are situated at a greater distance is equal to unity divided by the square of the distance. Thus, calling the attraction at a yard's distance "One", the attraction at two yard's distance will be a fourth part of that, at the distance of three yards a ninth part, at the distance of four yards a sixteenth part, and so on. It has been ascertained, by experimenting with a particular kind of balance, that what weighs 1000 ounces at the sea-shore, weighs 5 ounces less at the top of a given mountain. It may be asked,—how is this experiment possible?—when any thing is to be weighed, it is placed in one of the scales of the balance and the measure of weight in the other:—if the thing whose weight is to be measured weighs less at the top of the mountain, the measure also will there weigh less on account of the same cause. Now this objection applies only if it had been proposed to determine the point by means of the are spherical. They lose their spherical form, of course, when they reach the ground.

common balance. But, in order to determine the matter in question, we employ the strung bow [—to serve as a spring-balance]. We hold the bow by the middle, with its extremities downwards, and attach a body which weighs 1000 ounces to the middle of the string. Then whatever amount of bending takes place at the sea-shore, the same amount does not occur at the top of the mountain, but less than that. And the higher the mountain, the less the weight; for, the higher the mountain, the less is the bending of the string; and, to make the amount of bending the same as at the sea-shore, an addition to the weight is necessary. On such data it is ascertained by calculation that the body which weighs 1000 ounces at the earth, would weigh only five ounces if removed to the distance of the Moon.

(2). In pouring water from some kinds of vessels [such as a mug] the water does not at once fall vertically, but runs down along the inclined outside of the vessel, in consequence of the attraction between this and the water. Hence the difficulty of pouring from a vessel which has not a projecting lip. It is in order to remove the water from the attraction of the vessel, that various vessels are furnished with spouts,—as it is case with the water-pots of Hindú ascetics. When a vessel has not a spout, you may pour from it without spilling, by leaning the lip of the vessel against a rod of glass, or the like, down which the liquid will readily run,—the attraction of the rod then counteracting that of the vessel.

(3). Particles of water cohere among themselves in a degree which causes small needles gently laid on the surface to float: the weight of the needles is not sufficient to overcome the cohesion of the water-surface. For the same reason many light insects can walk upon the surface of water without being wetted.

(4). Between two plates of glass, or the like, standing near to each other with their lower edges in water, the water, attracted by them the more strongly in proportion to their closeness, rises above the level of that on the outside. In the same way water, ink, or oil, coming in contact with the edge of a book, is rapidly absorbed far inwards among the leaves, and the wick of a lamp lifts the oil, to supply the flame, from two or three inches below it.

(5). Now we proceed to explain the force called Repulsion.

*Aphorism IX.*

Repulsion is a force tending to separation.

(1). This force exhibits its effects when heat is diffused among the atoms. Thus ice when heated becomes water, on account of the separation of its particles: and water, when further heated, becomes steam. On this point we proceed to declare as follows.

*Aphorism X.*

The atoms are more or less close, according to the quantity of heat, producing repulsion, among them; and hence the forms of solid, liquid, and aëriform.

(1). But what is Heat? This question we will consider in the sequel.

(2). When a continued addition of heat is made to any body, the heat gradually increases the mutual distance of the constituent atoms, or, in other words, dilates the body. A solid thus is at first enlarged and softened; then melted or fused, that is to say, reduced to the state of liquid, as the

cohesive attraction is overcome; and lastly the atoms are repelled to still greater distances, so that the substance is converted into an elastic fluid or air. Abstraction of heat from such air causes a return of states in the reverse order Thus ice when heated becomes water, and water when further heated becomes steam. The steam when cooled becomes water, as before, and the water when cooled becomes ice. Therefore it is ascertained that ice, water, and steam, are three forms or states of the same substance. Other substances are similarly affected by heat, but as some require more heat to liquify them, and some less, it is thus that we find the existing variety of solids, liquids, and airs.

(3). In the Section on Heat we will explain the instruments employed in determining the higher and lower degrees of heat.

(4). We have now to consider some peculiarities of state which depend on certain modifications of Attraction and Repulsion.

*Aphorism XI.*

Certain modifications of Attraction and Repulsion produce the peculiarities of state called Crystalline, Porous, Dense, Hard, Elastic, Brittle, Malleable, Ductile, and Tenacious.

(1). "Crystalline"? When various kinds of salts are dissolved in water, and the water is then allowed slowly to evaporate, each salt assumes a peculiar form and no other. From finding that certain substances thus invariably assume a regular form, we infer that, at the time when a mass is beginning to be formed, the Atoms do not attract one another equally all round, but that the Attraction acts between certain sides or portions, thus leading to the regular arrangement which we call the Crystalline.

(2). "Porous"? Even among the particles of hard stones there are vacant spaces. Hence a kind of sandstone, suitably shaped, serves to filter water. Let the cause of its being fitted for this be called its Porosity.

(3). "Dense"? A cubic inch of mercury is nearly fourteen times heavier than a cubic inch of water. It is inferred that a greater quantity of Atoms exists in a given bulk of that which is the heavier. This is expressed by saying that the substance is more dense. When a body dilates or contracts by the addition or abstraction of heat, its entire weight does not change, because the quantity of its atoms does not change; but the weight of a given bulk of it, as a cubic inch, changes, because the quantity of atoms in the cubic inch changes. The condition of a body in this respect is what is called its Density.

(4). Hardness is measured generally by the circumstance of one body's being capable of scratching another. Thus diamond is reckoned the hardest of known substances:—it cuts or scratches every other body, and it is generally polished by means of its own dust.

(5). Elasticity is that which restores to its former position what had been forcibly altered, as by bending.

(6). Brittleness is the property of a body which, though hard, is easily broken. For example, glass scratches iron, so that it is harder than iron,—yet it is very easily broken.

(7). Malleability is the property, belonging to gold &c., of being reducible into thin leaves by hammering.

(8). Ductility means the susceptibility, belonging to gold &c., of being drawn into wire.

(9). The property, by its possession of which in a high degree, an iron wire can support a very great weight fastened to its end, but by the possession of which in a low degree, only a comparatively small weight can be supported by a leaden wire, is called Tenacity. Tenacity, differing in degree in different substances, is most remarkably characteristic of iron.
(10). Now we proceed to explain the particular force called Inertia.

*Aphorism XII*

That force which tends to prevent change either of motion or of rest, is called Inertia.
(1). Inertia? As a potter's wheel, when made to revolve, at first offers resistance to the force moving it, but gradually acquires speed proportioned to that force, so likewise it resists being again stopped. So a person standing upright in a carriage falls backwards when the carriage suddenly moves forwards; and the same person standing upright whilst the carriage is moving rapidly forward, falls forwards when the carriage suddenly stops. So too it is well known that, when a boat crossing a river strikes against the bank, all the ignorant people who in their haste to get ashore have stood up, fall forward towards the bank. Thus all bodies and atoms appear to have, in regard to motion or rest, a stubbornness, tending to keep them in the existing state whether of motion or of rest. Let the cause of this be called Inertia.
(2). Now, with the view of explaining Motion and Rest, the principal topics now under consideration, we first define the word Motion.

*Aphorism XIII.*

Motion is the act which leads to the changing of place among bodies.
(1). It is plain that, the absence of all motion is rest.
(2). Now, we proceed to explain that the state of motion is as natural as that of rest, in order to remove the vulgar opinion that the state of rest is natural, but that that of motion is adscititious.

*Aphorism XIV.*

Uniform straight motion is as naturally permanent as rest.
(1). Naturally permanent means, capable of continuing permanently.
(2). As Rest is not removed without a cause, so Motion also is neither decreased nor increased nor altered in its direction without a cause.
(3). When an iron ball is rolled on the ground, if the ground be not smooth, the motion is speedily destroyed. If the ground be smooth, then the motion, being less impeded, continues longer; yet it is gradually destroyed by obstacles which cannot here be entirely removed. It is only in the sky that we observe an entire absence of obstructions, and there the motions of the planets go on uninterruptedly.
(4). An arrow, discharged horizontally at a mark, gradually bends downwards to the earth by which it is attracted, but, when the air is still, it does not tend to change its course either to the right hand or to the left:—were it not for this, no one could calculate upon taking a correct aim.

(5). A stone from a whirling sling, the moment it is set at liberty, darts off as straightly as an arrow from the bow string; and it is only because of the great difficulty, even after long practice, of determining the point of the circle from which it should depart, that it is so difficult to hit a mark with it.

(6). From such examples as that of the sling it is inferred that a body moving in a circle is constrained by some force which is contrary to its Inertia, as the stone of the sling, when it is whirling, is constrained by the force of the hand which is opposed to its Inertia.

(7). Now we state the direction in which motion takes place.

*Aphorism XV.*

Motion takes place in the direction of the action of the force.

(1). Thus a boat is carried to the Eastward by the Eastward flowing current of the Ganges. When an additional force is applied in the same direction, it causes the body to move more rapidly in the same direction, as when a boat floating with the current of Ganges is urged in the same direction by the wind also. When a force is directly opposed by an equal force, motion does not take place; so two bulls of equal strength, opposing their heads with equal force, both maintain their ground. Whichever of two opposing forces is the greater, motion takes place in the direction of that force, with a r pidity dependent on the difference of the two forces; as when a boat, with a fair wind, sails up against the current of the Ganges.

(2). Now we explain the particular case when two forces act neither in opposite directions, nor in the same.

*Aphorism XVI.*

If two forces act, upon a body, neither in the same direction nor in exactly opposite directions, the body will move in an intermediate direction.

(1). Thus a boat impelled by oars across a river, and at the same time acted upon by the current, moves neither straight across, nor straight down the river, but slantingly. Therefore the ferry-man, in order to bring his boat the desired landing-place on the other side of a rapid river, calculating his own strength and that of the current, starts from such a point up the stream that the landing-place may lie rightly between the direction of the current and the direction that he labours in.

(2). Now we state the particular result where two forces act continuously upon a body, the one tending to carry it in the straight line, whilst the other directs it towards a fixed point.

*Aphorism XVII*

If two forces act upon a body, by one of which it is projected in a straight line, whilst by the other it is continually directed towards a fixed point, the result is Circular Motion.

(1). Thus when a sling, with a stone, is put in motion, the stone, which constantly seeks to move away, moves in a circle because it is restrained towards the hand. If, in the rapid motion, the string break, or if it be let go by the hand, then, since only one of the forces continues to act, the stone will fly off as if it had been thrown straight from the hand.

(2). So also in an oil-mill, the ox, when driven, seeking to go forward and prevented by the beam to which its neck is yoked, moves in a circle round the mill. If he were quit of the yoke, he would probably move off from his driver in a straight line,—his attempt to do this having conduced in the first instance to the circular motion which he is confined to.

(3). Now we state the common and the particular appellations of the two forces above mentioned.

*Aphorism XVIII.*

The force which draws a body towards a centre is called the centripetal force. The force [of Inertia] in virtue of which it tends to recede from a centre is called the centrifugal force. Together these two are called Central Forces.

(1). Phenomena exemplifying the centrifugal force are such as the following.

(2). Bodies laid on a whirling horizontal wheel, such as that used by potters, are rapidly thrown off.

(3). In a hand-mill, the grain, carried round by the stone, travels outwards till it escapes as flour at the circumference.

(4). When a water-pot, filled with water, is whirled rapidly round by means of a string fastened round its neck, the centrifugal force prevents the water from falling out even whilst the vessel is upside down.

(5). A man or a horse suddenly changing his direction in running [as when turning a corner at speed], instinctively leans inwards or towards the new direction, to counteract the centrifugal force that would throw him away from it. An inanimate thing such as a carriage, in rapidly rounding a corner, for want of such instinct, is apt to be overturned.

(6). When a mass of very soft clay is placed in the middle of a potter's wheel rapidly revolving, the centrifugal force causes the clay to bulge out.

(7). Now we divide Motion.

*Aphorism XIX.*

Motion is twofold, straight and curved.

(1). Motion in one uniform direction is called straight; as that of a falling body. Curved motion is other than this.

(2). We may divide motion otherwise.

*Aphorism XX.*

Motion is of two kinds, uniform and not uniform.

(1). Motion is said to be uniform when equal spaces are moved over in equal times; and that which is not such is not uniform.

(2). In regard to motion of the latter kind, we have to remark as follows.

*Aphorism XXI.*

Motion may be Retarded or Accelerated.

(1). Retarded motion is produced by some force acting continuously on a body in a direction opposed to that which first put it in motion, and thus gradually diminishing its velocity. If you throw a stone vertically upwards, the attraction of the Earth will gradually diminish its velocity, till at length

the upward motion ceases, and the stone begins to descend. The motion of the stone downwards is the converse of what it was upwards. Here we have Accelerated motion. For, when the stone, by falling through a certain space, acquired a certain velocity, it would move, in consequence of its Inertia, through another equal space in an equal portion of time, without the application of any additional force:—but the force of the Earth's attraction is constantly acting upon it, and thus the velocity is constantly accelerated.

(2). When a boy lets a ball drop from his hand, he can catch it again in the first instant; but after a little delay his hand pursues it in vain.

(3). When a mango fruit falls from a lofty branch, the eye can follow it for a time, and mark the gradual acceleration of its descent; but soon, from the increasing rapidity of its fall, it is seen only as a shadowy line.

(4). Any fluid falling from a reservoir forms a descending stream of which the bulk diminishes, from above downwards, in the same proportion as the velocity of the particles increases. For example, in pouring molasses or thick syrup, from a considerable height, the bulky sluggish mass which first escapes is reduced, before it reaches the bottom, to a small thread; but the thread is moving proportionately faster, and it fills the receiving vessel with surprising rapidity.

(5). As the velocity of a falling body is accelerated by the attraction of the Earth, a light leaf ought to fall with the same velocity as a stone, because the accelerating influence of the Earth affects alike the leaf and the heavy stone; but it is on account of the interference of the air that the leaf does not fall rapidly. For the same reason, gold, when beaten into thin leaf, does not fall rapidly, but floats in the air.

(6). A piece of paper, cut to the size of a rupee, and placed on the top of it, reaches the ground along with the rupee, for the heavier body prevents the air from impeding the fall of the lighter one.

(7). In a vessel from which the air has been removed by an air-pump, a rupee and a feather fall with equal rapidity.

(8). A stone thrown straight forward is gradually drawn downwards on account of the Earth's attraction. If the motion caused by the Earth's attraction were a uniform motion, like that caused by the current of a river, the stone, like the boat before referred to, would move in a slanting but straight line. As the downward motion, however, is a continually accelerated motion, the stone must continually change its direction; or, in other words, it must move in a curve, as we see it do. The form of this curve is more distinctly seen when water is spirted from a syringe.

(9). Now, since Motion both accelerated and retarded is exemplified in the Pendulum, we, therefore, as it bears upon the matter in hand, give a definition of the Pendulum.

*Aphorism XXII.*

The name of Pendulum is applicable to any body so suspended that it may swing freely backwards and forwards.

(1). A common Pendulum consists of a ball suspended by a rod from a fixed point.

(2). A stone suspended by a string will serve to exemplify several of the phenomena of the Pendulum. One of the most important of these is the following.

*Aphorism XXIII*

The times of the vibrations of a Pendulum are [very nearly] equal, whether it be moving much or little.

(1). This may be shown by suspending a small weight from a peg by a thread of 39 inches in length. When the weight is drawn to one side and then set free, it will move backwards and forwards in equal spaces of time, viz, in a second of time, whether it make a wide oscillation, as when first set free, or a gradually smaller one.

(2). It is in reliance on this property that the pendulum is employed to measure time. A common clock is merely a pendulum, with wheel-work attached to record the number of vibrations, and with a weight or spring having force enough to counteract the retarding effects of friction and the resistance of the air.

(3). Now we have to mention another property of the pendulum.

*Aphorism XXIV.*

The length a pendulum determines the time of its vibrations.

(1). The shorter the string of the pendulum, the more rapid is its oscillation; and the longer the string the slower is the oscillation.

(2). Having finished this incidental explanation, we revert to the consideration of the characters of Motion.

*Aphorism XXV.*

Action and Reaction are equal and opposite.

(1). It is evident that if no action or movement takes place among bodies except in consequence of either Attraction or Repulsion, there must always be at least two bodies concerned, and each must be attracted or repelled just as much as the other, although one will have less velocity than the other, as it may be itself greater, or fixed to another mass.

(2). Thus, if a man in one boat pull at a rope attached to another, the two boats will approach. The boat which he pulls will *come*, and the boat in which he stands will *go* towards the other. If they be of equal size and load, they will both move at the same rate; and if they be different, the smaller will move the faster, in whichever of them the man may be.

(3). A cannon, when fired, recoils with not less momentum in it than the ball has; but since the momentum in the cannon is diffused through a greater mass, the velocity is small, and easily checked.

(4). When a body in motion strikes upon another body, it meets with resistance. The resistance of the body at rest will be equal to the blow struck by the body in motion, and exactly opposed to it. The operation of this principle is most apparent in the case of elastic bodies.

(5). If an elastic ball be rolled along a smooth floor so as to meet a wall perpendicularly, it will return on the same line. If the first motion be not in a direction perpendicular to the wall, the reflected motion will diverge exactly as much on the other side of the perpendicular. Thus, if, whilst standing in the left-hand corner of a room, we throw the ball against the centre of the opposite wall, the ball, in returning, will move towards the right-hand

corner,—the angles on each side of the perpendicular being always equal. In regard to this we state as follows.

*Aphorism XXVI.*

The angle of reflection is equal to the angle of incidence.

(1). Having thus shown how all the motions visible among bodies are the effects of Attraction and Repulsion overcoming the Inertia of Atoms, separate or conjoined, we now proceed to explain, by means of these principles, the peculiarities of rest and motion which depend on the solid form of bodies.

## Section II.—Statics and Dynamics of Solids.

(2). Solid is the term applied to a mass in which the mutual attraction of the atoms is so strong that the mass may be moved about as one body without the relative positions of the component parts being thereby disturbed.

(3). We state a fact resulting from this character of solidity.

*Aphorism XXVII.*

Force, moving part of a solid, must affect the whole or break off the part.

(1). An earthenware vessel may be suspended by a portion of its lip [or by its handle], thus proving that the cohesion of the parts is stronger than the weight of the vessel; but if an attempt be made to lift the vessel quickly by such a part, the part may rise and leave the vessel behind, because then the inertia is acting together with the weight to destroy the cohesion.

(2). We have to notice another fact resulting from the same character.

*Aphorism XXVIII.*

In every mass, or system of connected masses, there is a point around which all the parts balance each other; and this point is called the Centre of Gravity [or of Inertia].

(1). Thus, if any uniform rod be supported by its middle, like a weighing beam, the two ends will just balance each other. If equal weights be hung at the extremities of the arms, the equilibrium will still continue. The middle point in this case is called the centre of gravity; and there is such a point in every mass.

(2). When this point is supported, the body does not fall. When this point is not supported, the body falls to that side on which the point is. Thus the centre of gravity of a bar of wood of uniform thickness being at the middle point, support this point on your finger and the bar will remain supported. Move the point to either side and the bar will fall on that side.

(3). A line drawn perpendicularly to the surface of the earth from the centre of gravity is called the line of direction. A body remains standing when the line of direction falls within the base.

(4). When people in a boat rise up, the centre of gravity of the whole,—that is to say of the boat with is contents, is raised. A smaller inclination of the boat to one side will then make the line of direction fall beyond the

base, in which case the boat will be upset. Passengers, therefore, ought to avoid starting up.

(5). The centre of gravity of a sphere is the centre of the sphere. Wherever you place a spherical body of homogeneous material, on a horizontal plane, the centre of gravity being vertically over the point of contact, the sphere will rest. On the other hand, if you place the sphere on a slope, the point of contact not being vertically under the centre of gravity, the body will roll down.

(6). The centre of gravity of a body is not necessarily within the body itself. In a ring, of iron for instance, the centre of gravity is somewhere within the hollow in the midst. The method of finding it [in such a case] is as follows. Suspend the ring successively from two several points, and tie two threads across in it the direction of the two vertical lines of suspension. The centre of gravity of the ring is where the two threads intersect each other. For, if you support the point of intersection, the ring will be balanced.

(7). On these properties of matter, and laws of motion, which we have described, depends the operation of numerous machines which have been contrived for the saving of human labour.

(8). Here we must state another fact dependent on solidity.

*Aphorism XXIX.*

In a body moving about an axis, as a wheel or a weighing beam, the different parts have different velocities, according to their respective distances from the axis or centre.

(1). This fact becomes apparent on looking at a potter's wheel revolving. Thus a piece of soft clay, placed on the rim of the wheel, passes over, in one revolution, twice the space traversed by another piece placed midway between the centre and the circumference.

(2). We now state another result of solidity.

*Aphorism XXX.*

Forces, with different speed, may be made to balance one another, if they be connected by some solid medium in such a manner that the speed of the smaller shall be greater, just in proportion to the greater intensity of the other force.

(1). Upon this important truth the whole of Mechanics may be said to hinge. On this depends the operation of the simple machines, or mechanical powers, as they have been called,—the lever &c.,—which enable man to adapt any species and speed of power which may be available, to almost any work which he has to accomplish.

(2). A lever is a rigid rod of uniform thickness, made, we may suppose, of wood, or metal.

(3). If the rod be placed with its centre resting on a support, which is called the fulcrum, the two arms of the lever will balance each other. If equal weights be hung at the extremities of the arms, the equilibrium will still continue. On this principle the common weighing balance is constructed.

(4). If the lever be supported not at the middle, but at such a point that the one arm shall be twice as long as the other, then the centre of gravity will be removed to the side of the longer arm; and a weight suspended from the extremity of the longer arm will balance twice its weight suspended from the extremity of the shorter arm. Therefore it is evident that if the

arms of a weighing balance are unequal in length, an imposition in the weight of goods may be effected.

(5). By moving the fulcrum still nearer to one end, a weight at the extremity of the longer arm may be made to balance three times, four times, five times its weight at the other end, and so on indefinitely; and a small addition to the weight at the longer arm will enable it not merely to balance but to raise the larger weight. Thus a single person, by applying his strength at the longer end of a lever, is able to raise a weight which the combined force of several men could not move.

(6). It is obvious that the extremity of the longer arm must be moved over a great space, in order to raise the extremity of the shorter arm through a small space; and thus, just as much as is gained in power is lost in time. This applies not only to the lever but to all the mechanical powers. It does not follow, however, that these are useless, for, since we cannot augment our strength, those instruments are highly useful which enable us to reduce the resistance or weight of any body to the level of our strength, at the expense of a corresponding portion of time.

(7). Another great benefit resulting from the use of machinery, as already hinted, is this, that it enables us to take advantage of gratuitous forces, such as the rushing of wind, or of water, or the expansive power of steam. When such forces perform our task, we have only to superintend and regulate their operation

(8). So much for the mechanical characters of solid bodies.

(9). In connection with this subject we may here declare something regarding the *causes* of those motions among the heavenly bodies, the description of which is the business of Formal Astronomy.

## SECTION III.—PHYSICAL ASTRONOMY

(10). First, we proceed to explain the reason why the Moon revolves round the earth.

### *Aphorism XXXI.*

The Moon revolves round the Earth on account of its motal Inertia and the Earth's attraction.

(1). "On account of its Inertia". When we observe a man at a distance moving his hand, and a ball revolving round him, we do not see the string between his hand and the ball, but still we conclude that there must be something such as a string which connects his hand and the ball. In the same manner, seeing the Moon's circular motion, we infer that there is some other force which counteracts the straight motion due to her motal Inertia; for circular motion cannot take place with one force only. This other force is nothing else than the Earth's attraction.

(2) If it be asked,—since, according to the law which was mentioned before, that all bodies attract each other, the Moon also attracts the Earth; why then does not the Earth revolve round the Moon?—we reply, that, two bodies, revolving in the heavens, which are connected with each other, revolve round the common centre of gravity which lies from either of them at the distance proportioned to their reciprocal masses. This fact becomes manifest on observing the mode of revolution of two balls attached to the extremities of a rod whirled up into the air. The more one of them is greater than the other, the more the common centre of gravity lies near the greater, and thus when

the common centre is in the larger mass, the smaller revolves round the larger whilst both of them revolve round the common centre. Thus the Earth and Moon, connected with each other by their mutual attraction, revolve round their common centre of gravity which lies from each of them at the distance proportioned to their reciprocal masses. But as the mass of the Earth is a hundred times greater than that of the Moon, the common centre lies *within* the mass of the Earth, and so the Moon revolves round the Earth whilst both are revolving round the common centre.

(3). Now, we state that this is the case with other planets also such as the Earth &c.

*Aphorism XXXII.*

In like manner the planets, Mercury, the Earth &c., revolve round the Sun, in consequence of their Inertia and the attraction of the Sun.

(1). "In like manner":—As, when the Earth and the Moon revolve round their common centre of gravity, the Moon revolves round the Earth, on account of the Earth's mass being much greater than the mass of the Moon, so, when the Sun, the Earth and the other planets, Mercury &c., revolve round their common centre of gravity, all the planets, the Earth &c., revolve round the Sun because the mass of the Sun is very much greater than that of the whole of the planets, and consequently the common centre of gravity lies within the mass of the Sun. In the same way we can account for the revolution of all the satellites round their primary planets.

(2). We have next to consider the mechanical properties peculiar to matter in the form of *liquid.*

## SECTION IV.—THE PHYSICS OF LIQUIDS.

### HYDROSTATICS AND HYDRODYNAMICS

From their deficiency of cohesion, liquids cannot be maintained in heaps. The wind raises water into waves, but these are immediately afterwards destroyed by gravity. Thus :—

*Aphorism XXXIII.*

Liquids always tend to have their surface level.

(1). As the particles of fluids gravitate independently, they press against each other in every direction, not only downwards but upwards, and sideways. The pressure of fluids upwards, though it seems in direct opposition to gravity, is a consequence of their pressure downwards.

(2). When, for example, water is poured into a vessel with a spout, the water in the spout rises to a level with that in the pot. The particles of water at the bottom of the pot are pressed upon by the particles above them ; they will yield to this pressure if there is any mode of making way for the superior particles, and as they cannot descend, they will change their direction and rise in the spout.

(3). For the same reason water may be conveyed to every part of a town, if it be originally brought, by means of pipes, from a height superior to any to which it is to be conveyed. Many of the cities of Europe are supplied with water in this way.

(4). We have already had occasion to mention the *specific gravity* of bodies :—well—

*Aphorism XXXIV.*

Water is employed as the standard for determining the comparative weight, or specific gravity, of bodies.

(1) When we say that a substance is light or heavy, we speak comparatively. Thus chalk is light when compared with iron, and heavy when compared with wood.

(2). The comparative weight or specific gravity of a body is ascertained by weighing it first in air and afterwards in water.

(3). A piece of gold will displace just as much water as is equal to its own bulk; so that a cubic inch of water must make way for a cubic inch of gold. The gold will weigh less in water than it did out of it, on account of the upward pressure of the particles of the water. Now supposing that a piece of gold weighed nineteen ounces out of the water, and lost one ounce by being weighed in water, the quantity of water which it displaces must weigh that one ounce: consequently gold must be nineteen times as heavy as water.

(4). If the body under trial be of the same weight as the water in which it is immersed, it will be wholly supported by it, as was the water the place of which it occupies. Thus a body placed in water rests when it has displaced a quantity of water equal in weight to the weight of the body; but if the bulk of the body be less than that of its weight of water, as in the case of a ball of clay, it will sink. If the ball of clay be formed into a hollow jar, then it will displace a quantity of water more than equal to it in weight, and it will float.

(5). Thus a boat sinks the deeper in the water the more it is loaded, displacing just as much water as is equal to the whole weight; so that even iron boats can be made to float. Steamboats on the Ganges are made of iron.

(6). In ascertaining the specific gravity of a body lighter than water, it is necessary to attach to it a body of known specific gravity sufficiently heavy to sink it.

(7). Water, oil, milk, &c. are fluids which possess very little elasticity. Such fluids are called liquids. Other fluids have a remarkable degree of elasticity. Let us now consider, then, the physical properties of *elastic* fluids, or Airs.

## Section V.—The Physics of Elastic Fluids.

### Pneumatics, or Aerostatics and Aerodynamics.

*Aphorism XXXV.*

The leading character in which air differs from such a fluid as water is its elasticity.

(1). By the elasticity of air we mean its power of increasing or diminishing in bulk, accordingly as it is less or more compressed.

(2). In consequence of its elasticity, air presses in all directions.

(3). An important property, in respect of which air resembles water, is the following:

*Aphorism XXXVI.*

The air possesses weight.

(1) The following are proofs of this fact.

(2) When we suck water through a straw, we do it by expanding the chest, this diminishes the compression of the air within our body, which then no longer counterbalances the pressure of the external air on the surface of the water, by which the water is consequently forced up the straw.

(3). The weight of a small quantity of air may be ascertained by exhausting the air from a bottle, by means of an air-pump, and weighing the bottle thus emptied. If the air be then re-admitted and the bottle be re-weighed it will be found heavier. The difference is the weight of the air.

(4). In order to ascertain the specific gravity of air, we may employ a bottle that holds six cubic inches. The weight of six cubic inches of water will be found to be 1515 grains, and that of so much air 2 grains: so that the weight of the water to that of air is about 800 to 1.

(5). For certain reasons it is supposed that the atmosphere is about 45 miles high. The weight of the upper portions causes the lower portions to be more dense. At the top of a high mountain the air is so thin that considerable difficulty is found in breathing there.

(6). The height of a mountain may be estimated by means of an instrument called a *barometer*, or measurer of the weight of the air.

(7). A barometer may be made thus. Fill with mercury a glass tube about three feet in length, and open only at one end. Then stopping the open end with the finger, immerse it vertically in a cup containing mercury. Part of the mercury which was in the tube now falls down into the cup, leaving a vacant space in the upper part of the tube, to which the air cannot gain access.—This space is therefore a perfect vacuum; and consequently the mercury in the tube is relieved from the pressure of the atmosphere, whilst that in the cup remains exposed to it. Therefore the pressure of the air on the mercury in the cup supports that in the tube, and the mercury will stand higher in the tube when and where the pressure of the atmosphere is greater.

(8). The mercury in the barometer usually stands at the height of about 29½ inches. When the *barometer* is carried up a hill, or to the top of a high tower, the atmospheric pressure being diminished, the mercury sinks. By means of numerous experiments it has been determined how many hundred or thousand feet of additional elevation correspond to a fall of an inch, or two inches, &c., of mercury in the tube, and thus it is that the instrument can be employed for measuring the height of mountains.

(9). The mercury also sinks on the approach of a storm, so that it is of great value for giving warning of an approaching storm to ships at sea.

(10). The atmospheric pressure which sustains in a tube a column of 29½ inches of mercury, ought to sustain a proportionately higher column of a fluid the specific gravity of which is less.—The specific gravity of mercury as compared with water is 13½. Multiplying this by 29½, the number of inches of mercury, we get somewhat more than 33 feet; and accordingly, on making the experiment, we find that the atmospheric pressure sustains a column of water of above 33 feet in height.

(11). The relative specific gravity of two fluids which, like mercury and water, are not disposed to mix with each other, may be determined by the following method. Place a glass tube, curved like the goad of an elephant, with the ends of the limbs uppermost, and pour into it so much of each of the two fluids that their point of meeting shall be the lowest point in the curvature of the tube. Then the heights at which the two fluids stand in the

respective limbs will be in the inverse ratio of their relative specific gravity. For example, in such an arrangement, an inch of mercury in the one branch of the tube will be found to balance 13½ inches of water in the other; so that we conclude that mercury is 13½ times as heavy as water.

(12). When such a curved tube as we have just described is reversed, it is called a syphon. Such is the instrument described by *Bháskara A'chárya* in his *S'iromaṇi Mitákshara,* in the chapter on machines, where he says that if we place one end of such a curved tube, of copper or some other material, in a vessel full of water, the tube also being filled with water, and leave the other end open outside the vessel, all the water in the vessel will flow out through the tube.

(13). In the same way if you use the hollow stalk of a lotus, the flower having been removed, a vessel of water may be emptied by it. Many ingenious machines are constructed on the principle of the syphon by conjurors and other artists.

(14). The action of the syphon depends upon the weight of the atmosphere. The column of water in the external limb being longer than that in the limb immersed in the vessel, is heavier also. When it begins to fall, a vacuum would be formed in the upper part of the tube if the water in the shorter limb were not immediately forced to ascend, by the pressure of the atmosphere on the surface of the water in the vessel.

(15). As the air is the most common vehicle of sound, though not the only one, we may here treat of the subject of Sound.

## Section VI.—Acoustics

### *Aphorism XXXVII.*

Sound is heard when any sudden shock or impulse is given to the air, or to any body which is in contact, directly or indirectly, with the ear.

(1). Thus sound, as that of a bell, can be heard under water.

(2). Solid bodies also convey sound, as may be thus proved. Fasten a string, by the middle, round a bar of iron, and raise the bar from the ground by the two ends of the string, one end being held against each ear closed. If the bar be then struck with another piece of iron, the sound will be conveyed to the ear by means of the strings in a much more perfect manner than if it had no other vehicle than the air.

(3). When a sonorous body, such as a bell, is struck, it is put into a state of rapid vibration. This vibration it communicates to the air, and the air communicates it to our ear, where it produces the sensation of sound.

(4). A bell rung in a vessel from which the air has been removed, gives no sound.

(5). The tremulous motion given to the air by the vibration of a sonorous body resembles in some measure the motion communicated to smooth water when a stone is thrown into it. A stone thrown into smooth water, first produces a small circular wave round the spot where the stone falls; the wave spreads, and gradually communicates its motion to the adjoining waters, producing similar waves to a considerable extent.

(6). It requires some time for the vibrations of the air to extend to any distant spot. A washerman at some distance is seen to strike a mass of wet clothes upon a stone some time before the sound of the blow is heard.

*Aphorism XXXVIII*

The velocity of sound in air is computed to be at the rate of 1142 feet in a second.

(1). The nearly uniform velocity of sound enables us to estimate the distance of the object from which it proceeds. If we do not hear the thunder till half a minute after we see the lightning, we infer that the cloud is at the distance of six miles and a half.

*Aphorism XXXIX.*

An echo is produced when the aerial vibrations meet an obstacle.

(1). When the waves raised in a tank, by throwing a stone into it, meet the bank, they are reflected. So an echo is produced when the aerial vibrations meet with an obstacle having a hard and regular surface, such as a wall or a rock. The vibrations may thus be reflected back to the ear, and produce the same sound a second time; but the sound will then appear to proceed from the object by which it is reflected; just as the image reflected by a mirror seems to the eye to be behind the mirror.

(2). If the vibrations fall perpendicularly on the obstacle, they are reflected back in the same line; if obliquely, the sound returns obliquely on the other side of the perpendicular, the angle of reflection, in this case as in others, being equal to the angle of incidence.

(3). In solids, liquids, and even airs, we have found that *weight* presents itself, as a result of Attraction. But in the great cause of *Repulsion*, viz. Heat, though we find some properties which it has in common with the bodies already treated of, we do not find any evidence of weight.

(4). We proceed to treat of Heat, and of the other imponderables, Light, &c.

## Section VII.—Of Heat.

*Aphorism XL.*

Heat cannot be exhibited apart, nor be proved to have weight or inertia.

(1). An iron ball, by being heated, does not gain in weight.

*Aphorism XLI.*

Heat diffuses itself among neighbouring bodies until all have the same temperature.

(1). A heated iron ball, thrown into a vessel of water, becomes cooled while the water becomes heated.

*Aphorism XLII.*

The inferior degrees of heat are denoted by the term *cold.*

(1). A man who has descended half way from the summit of a pass in the Himálaya, exclaims—"How warm the air is!"—while the man who has just arrived at the same point from the plains, rejoins, "On the contrary—how very cold!" The air feels hot or cold to each of these two because its heat is greater or less than that of the air that he has left. Thus we learn that Sensation is not a perfect criterion of Heat.

(2). As these two men give opposite evidence, from their feelings, so a man's two hands may give opposite evidence in regard to the heat of a basin of water. Put your right hand into as cold water as you can procure, and your left hand at the same time into as hot water as it can suffer, and, after a little time, place both hands in a basin of tepid water. To the right hand it will feel warm; and to the left hand cold. This shows still more clearly that Feeling is not a trustworthy thermometer.

*Aphorism XLIII.*

Heat expands bodies, and hence any substance so circumstanced as to allow the expansion to be accurately measured, constitutes a Thermometer.

(1). The common thermometer, or instrument for measuring the degrees of heat, is a glass bulb filled with mercury or other fluid, and having a narrow tube rising from it, into which the fluid, on being expanded by heat, ascends, and so marks the degree of heat.

*Aphorism XLIV*

Heat travels through different substances with different degrees of rapidity.

(1). A burning match can be held till the flame comes near the fingers; but a metallic wire, if one end be put into the flame of a lamp, speedily becomes too hot to be held.

*Aphorism XLV.*

Heat travels also through space.

(1). It is then called Radiant Heat.

(2). Heat proceeds from a heated body, such as an iron ball, in straight lines, and in all directions. The law of the equality of the angles of incidence and reflection applies to these rays. If the rays proceeding in this way from the Sun are received in a concave metallic mirror, they will be all reflected into one point, where the heat will be sufficient to set various substances on fire. Two such mirrors facing each other may be so arranged at opposite ends of a room that food placed in front of one of them shall be cooked by a fire placed in front of the other.

(3). It is through the radiation of heat, as explained in Book 2nd, that bodies at night become cold and are bedewed. Advantage is taken of this property, in Upper India, to freeze water during the clear nights of the cold weather. The ice is then stored up under-ground for use during the hot weather. The vessels containing the water to be frozen are placed upon dry straw, which, not being a good conductor of heat, does not allow heat from the ground to replace that which is radiated from the water.

*Aphorism XLVI.*

Heat may be developed by friction.

(1). When bodies are rubbed together they become heated. The friction of two pieces of wood is sometimes employed for the purpose of procuring fire.

(1). What is strongly heated gives out Light. Like Heat, Light, also, is imponderable. The agency of Light in the phenomena of vision is the object of enquiry in the important department of science which we proceed next to treat of.

## Section VIII —Optics

In this science, bodies are divided into *luminous, opaque,* and *transparent.* A luminous body is one that shines by its own light, as the sun, or a lamp. Polished metal, though it shines, is not luminous, for it would be dark if it did not receive light from a luminous body. It belongs to the class of opaque bodies which are neither luminous nor will allow the light to pass through them. Transparent bodies are those which allow the light to pass through them, such as glass and water. Transparent bodies are frequently called Mediums.

### *Aphorism XLVII*

Light when emitted from a luminous body is projected in straight lines in every direction.

(1). When the rays of light meet an opaque body, they are stopped short in their course. The interruption of the rays of light by the opaque body occasions darkness on the opposite side of it. If this darkness fall upon a wall or the like, it forms a shadow.

(2). A shadow is not generally quite black, because it usually happens that light from another body reaches the space where the shadow is found, in which case the shadow is fainter. This happens if the opaque body be lighted by two lamps. If you extinguish one of them, the shadow will be both deeper and more distinct; yet it will not be perfectly dark, because it is still slightly illuminated by light reflected from the walls of the room, and other surrounding objects.

(3). If the luminous body be larger than the opaque body, the shadow will gradually diminish in size till it terminate in a point. Thus the shadow of the moon, in an annular eclipse, terminates before it reaches the earth.

(4). If the luminous body be smaller than the opaque body, the shadow will continually increase in size as it is more distant from the object that projects it. Thus the shadow of a man, thrown upon a wall by a lamp, may be twenty feet high or more.

### *Aphorism XLVIII.*

Light moves with great velocity.

(1). Light is about eight minutes and a half in its passage from the sun to the earth; therefore, when the rays reach us, the sun has quitted the spot he occupied on their departure; yet we see him in the direction of those rays, and consequently in a situation which he had abandoned about eight minutes and a half before.

(2). The rate of the velocity of light was discovered in the following manner. We have already mentioned that the planet Jupiter is attended by four moons, which are very frequently eclipsed. When the earth is between Jupiter and the sun, then the earth is nearer to Jupiter, and when the sun is between the two, then the earth is further from Jupiter, by the

distance of the diameter of the earth's orbit. Having ascertained exactly the time of the occurrence of the eclipses when Jupiter is near the earth, astronomers calculated, in accordance therewith, the time of many future eclipses; but it was found that, when the planet was at its greatest distance, the eclipses did not become visible till about 16 minutes after the calculated time. It was inferred that light takes this amount of time to traverse the earth's orbit, and from this the velocity of light was determined as follows.—As the sun's distance from the earth is about ninety five millions of miles, Jupiter, when at his greatest distance, must be a hundred and ninety millions of miles further off than when he is at his least distance from the earth; and it follows that the velocity of light is nearly two hundred thousand miles per second.

*Aphorism XLIX*

When rays of light encounter an opaque body, after being stopped short they are mostly reflected, as an elastic ball when flung against a wall.

(1). Here as in other cases, the angle of reflection is equal to the angle of incidence. Admit a ray of the sun into a dark chamber by a very small hole, and let the ray fall perpendicularly on a mirror. Only one ray will be seen, for the incident and reflected rays are both in the same line, though in opposite directions. Hold the mirror so that the ray shall fall obliquely upon it, and the reflected ray will go off at the same angular distance on the other side of the perpendicular.

(2). It is by reflected rays alone that we see opaque objects. Luminous bodies send rays immediately to our eyes; but the rays which they send to other bodies are invisible to us, and are seen only when reflected by those bodies to our eyes. The path of the ray which we spoke of as falling on the mirror, and reflected from it, was discernible only by means of the light reflected to the eye by small particles of dust floating in the air, on which the ray shone in its passage to and from the mirror.

*Aphorism L.*

When light passes from one into another transparent medium, it is refracted.

(1). In consequence of this, when partly immersed in water, a staff appears shortened if it is placed vertically, and when it is placed obliquely the part immersed appears to be bent and broken off from the part above the water.

(2). From the phenomena of refraction it would appear that when a ray of light passes from air into water, it is more strongly attracted by the water. If the ray fall perpendicularly on water, the attraction of the water acts in the same direction as the course of the ray. But if it fall obliquely, the water will attract it out of its course, and make it proceed in a direction more nearly vertical.

(3). The converse is the case with a ray of light leaving a dense medium and entering a thinner one.

(4). To show this,—place a silver coin at the bottom of a cup, and set it so that the rim of the cup shall just intercept the rays of the sun or of a lamp, and leave the coin in the shade. On filling the cup with water, the rays being refracted downwards, will illuminate the coin.

(5). Again, having emptied the cup, replace the coin, and move backwards till the rim of the cup shall hide the coin. Then let the cup be filled with water and the coin will become visible; for the rays reflected from the coin, and not intercepted by the rim of the vessel, which previously passed above the eye, being now refracted downwards, meet the eye.

(6). For the same reason the bottom of a clear stream or lake appears more elevated than it really is. Ignorant boys, unable to swim, have lost their lives by going to bathe where the water did not appear to them to be deep.

(7). The rays coming from the sun or from a star when near the horizon, are refracted downwards when they enter the atmosphere. The situation of the heavenly body in such circumstances therefore appears to be higher than it really is, for the eye perceives an object in the direction which the ray coming from it takes at the instant when it meets the eye.

(8). The rays coming from a body in the zenith are not refracted.—The amount of refraction is greatest at the horizon, from which it gradually diminishes towards the zenith. Hence at sunrise the lower limb of the sun is more affected than the upper, and when the air is rendered more refractive by damp, the disk assumes a form approaching to that of an egg.

(9). In astronomical observations, allowance must be made for refraction. Tables of its amount, at all points between the horizon, where it is greatest, and the zenith, where it ceases, have been constructed, and are printed in Astronomical treatises.

(10). In passing obliquely through a pane of glass, a ray of light suffers two refractions. On coming from the thinner air into the denser glass, the refraction is towards a perpendicular to the inner surface of the glass. On passing from the denser glass into the thinner air, the refraction is equally away from a perpendicular to the outer surface. The two refractions therefore, being in contrary directions, produce nearly the same effect as if no refraction had taken place.

(11). But this is the case only when the two surfaces of the refracting medium are parallel to each other: if they are not, the two refractions may be made in the same direction. Thus when parallel rays fall on a piece of glass having a double convex surface, which is called a *lens*, that ray only is perpendicular to the surface which falls in the direction of the axis,—the axis being the straight line passing through the centre of the lens and perpendicular to both surfaces. All the other rays, meeting the surface obliquely, are reflected toward that perpendicular. When the rays quit the glass at the inner surface, they are again refracted towards the axis, by diverging from the perpendicular at the point where they leave the glass. Thus the whole eventually converge to a point behind the glass, called the *focus*, at about the distance of the radius of the sphere of which the surface of the lens forms a portion.

(12). The sun's rays may be collected to a focus by a lens which, when used for this purpose, is called a burning-glass, and a piece of paper held in the focus may be set on fire.

(13). A convex lens serves also as a magnifying glass.

(14). The reason of this as follows. An object at a distance from the eye appears small, and what is near appears large. A small object is seen with most distinctness, by a well constituted eye, when at the distance of about five inches. If it be brought nearer, it appears larger, but less dis-

tinct. This can easily be put to the test by holding the book at the distance first mentioned, and then nearer to the eye.

(15). The reason of the indistinctness in the latter case is as follows. In the fore-part of the eye there is a drop of pure liquid in the shape of a convex lens, the refractive power of which is such that rays diverging from a small object at the distance of about five inches are readily brought by it to a focus on the retina, where the concentration of rays produces distinct vision; but the refractive power is not sufficient to bring to a focus on the retina the rays diverging from a nearer object.

(16). When people grow old, the fluid which forms the lens begins to diminish, and the convexity decreases, so that the letters of a book at the distance of five inches do not appear distinct to an old man. He sees more distinctly when he holds the book at arm's length.

(17). This defect in the sight may be remedied in some measure by the use of convex spectacles, which cause the rays coming from any object to converge so far, before reaching the eye, that the lens of the eye can effect the rest.

(18). By interposing a very refractive lens, a small object may be viewed distinctly when brought very near the eye; and it then appears to be proportionately magnified. Such a glass is called a microscope.

(19) A small convex lens may be obtained by piercing a small circular hole in a slip of metal, and introducing into it a drop of water, which will assume a spherical form on each side of the metal. Objects looked at through this will appear magnified.

(20). If a lens be placed so as to fill up an aperture made in the window-shutter of a darkened room, and a sheet of paper be held at a proper distance behind it, then the objects outside, trees, houses, men walking, &c, will be represented on the paper. This arrangement is analogous to that which exists in the eye.

(21). The operation of a concave lens is the reverse of that of a convex lens. Objects seen through a concave lens are diminished.

(22). In some young persons the lens of the eye is so highly convex that the rays come to a focus before they reach the retina.—From this focus the rays proceed divergently, and consequently form a very confused image on the retina. Such persons see an object distinctly only when very near the eye.

(23). Short-sighted persons may enable themselves to see clearly at five inches distance by placing a concave lens before the eye, in order to increase the divergence of the rays.

(24). Short-sighted people may comfort themselves with the reflection that their eyes, by the flattening of the lens, may begin to improve, at a time of life when the sight of other people is beginning to fail.

(25). There are other objects which, though not really small, appear small to us, from their distance. In order to see these distinctly, we employ a Telescope.

(26). The simplest form of Telescope consists of a convex lens fixed at the end of a tube, by which the rays from a distant object are made to converge; whilst the rays, before they come to a focus, are received on a concave lens, which causes them to diverge so far as is necessary to give distinct vision. The object is thus seen magnified, and appears as if it were brought nearer.

*Aphorism LI.*

A beam of white light contains all the colours in nature.

(1). Holding a clear glass bottle full of water higher than his head, or placing it on a support where a ray from the sun, coming into a dark room, may fall upon it, let the observer place himself between the sun and the bottle; then the various hues which appear in the rainbow, will all be exhibited by the bottle. Let the bottle be raised or lowered until one of the coloured rays appears; then let the bottle be gradually raised, or lowered, and the other coloured rays will be seen in succession. Now how can such a variety of colours issue from clear water? The answer is this, that all these coloured rays are contained in a ray of white light. We must give some explanation of this.

(2). It has been already mentioned that opaque bodies are seen by means of the rays which they reflect. All objects do not reflect every portion of the white ray. A body which reflects every portion appears white. That which reflects none appears black.

(3). Along with the rays of light, the heat that attends them is either reflected or absorbed. Hence, in the sunshine, black clothes, which absorb the rays, are warm; and white clothes, which reflect them, are cool. Black cloth, for the same reason, takes fire quickly when exposed to a burning glass, but not so white cloth.

(4). A body which reflects the red rays, appears red; that which reflects the yellow rays appears yellow; and so in every case.

(5). The refrangibility of the coloured rays which make up white light is not equal. The blue rays are more refrangible than the yellow, and these than the red. This can be best shown by means of a prism of glass.

(6). Let this be placed so that the ray of light entering a dark chamber by a small hole shall fall upon it, then the ray which first threw a white light on the opposite wall, will display the various colours of the rainbow. The refractions of the light, entering and quitting a prism, are both in the same direction, as in the case of a convex lens, and for the same reason; but, as its sides are flat, the rays are not brought to a focus.

(7). If the coloured rays which have been separated by a prism are allowed to fall upon a convex lens, they will converge to a focus, where they will appear white as they did before refraction. Thus we can take a ray of white light to pieces, and put it together again.

(8). The sun appears red through a fog, and also frequently at rising and setting, because the red rays, being less refrangible, reach our eyes, whilst the more refrangible rays do not.

(9). The rainbow which exhibits a series of colours analogous to those of the prismatic spectrum, is formed by the refraction of the sun's rays in their passage through a shower of rain, every drop of which acts as a prism, in separating the coloured rays as they pass through it.

(10). As all the drops which are placed at the same angle as regards the eye give the same colour, and the location of all the drops which are at similar angular distances from the eye must be in a circle, the form of the rainbow, of which we see only a portion, is necessarily circular.

(11). It was mentioned that friction may develope Heat and Light. Another imponderable principle may be thus developed, which is termed [Electricity or] Lightning.

(12). Now, since what is familiarly understood by the term Lightning is merely a kind of light belonging to the clouds, in order to hint that in the present discussion the term Lightning [or Electricity] is to be employed in other senses also than that merely of such particular light, we declare how ordinary Lightning and what we mean by Electricity are identical.

### Section IX.—Frictional Electricity.

*Aphorism LII.*

Lightning is identical with the principle developed in amber by friction.

(1). When a piece of amber is rubbed with flannel, another phenomenon, besides heat, becomes manifested; for the amber then attracts light substances, such as chips of straw. If the piece of amber employed be very large, then sparks, each accompanied by a crackling noise, appear when a finger is presented to it, and a tingling sensation is experienced in the finger. As a drop of water resembles a large body of water in all its peculiar properties,—differing only in quantity &c.,—so it is only in *amount* that this spark, and crackling, and painful sensation in the finger, differ from a flash of lightning, with its attendant peal of thunder, and its destruction of a person struck by it. We shall therefore in Sanskrit, for convenience of exposition, term this principle, wherever we find it, Lightning. In English it is termed Electricity.*

*Aphorism LIII.*

Electricity, when in equilibrium, is latent:—its powers become manifested when the equilibrium is disturbed.

(1). Let us enumerate the principal marks by which we recognise Electricity when the equilibrium has been disturbed.

*Aphorism LIV.*

Electricity (1) gives light, (2) makes a noise in exploding, (3) attracts and repels, (4) is conducted by metals, (5) moves swiftly, (6) rends certain bodies in passing through them, (7) agitates or destroys animals, (8) fires inflammable substances (9) melts metals; &c.

(1). There are various processes which enable us to develope the characters here enumerated. For example, let a large stick of sealing-wax, or resin, be rubbed briskly with a piece of flannel:—it will give out bright sparks, with a snapping noise, when a finger is brought near it. We conclude from this that the sealing-wax, or resin, has, by the friction of the flannel, had its electrical equilibrium disturbed.

(2). Perhaps all bodies, by appropriate friction, can be brought into the state of electrical disturbance; but this is more readily effected with some [—termed consequently good electrics]—than with others. Glass is a good electric. Let a glass tube, [of about two feet long and two inches in diameter,] well warmed, be rubbed briskly with a silk cloth:—the glass tube, like the resin, will give out sparks.

(3). But the case of the resin and that of the glass, as we shall find, are not in all respects alike;—for—

* From the greek word for amber, viz., *Electron*.

*Aphorism LV*

The Electric State of excited Resin is usually opposed to that of excited Glass.

(1). The difference of character is proved by the difference in the effects produced. For example,—if a downy feather is held at some distance from the excited glass-tube, the fibres of the feather will be attracted towards the tube, and the feather, when liberated, will rush to the glass. In a short time, however, the downy parts will be observed to separate from each other, and when the feather is charged with electricity, it will fly off nearly as rapidly as it was attracted. The feather, when thus repelled from the tube, will not again approach, until it has parted with its charge of electricity; and, to get rid of this, it will rush towards the hand, or towards the nearest body that will receive the electricity. If, before the feather has had an opportunity of parting with the charge, the excited tube is brought near, then the feather is repelled further off, and it may in this way be chased round the room, and kept suspended in the air. Now, while the feather is being repelled by the excited glass-tube, excite a stick of sealing-wax, and then the feather which has been repelled by the glass will be attracted by the sealing-wax. Conversely, a feather first repelled by the sealing-wax will be attracted by the glass.

(2). From phenomena such as this, some have inferred that there are two opposite kinds of Electricity, to which they have given the names of Resinous and Vitreous, because the difference was first observed in the case of Resin and Glass. Others hold that there is only one kind of Electricity, which, like Heat, always tends to an equilibrium. When equally distributed, it remains at rest; but when unequally distributed, it manifests the electric characters (—see Aph. 54) in its efforts to regain the state of equilibrium. On this view, which we shall adopt as the simpler, the glass is *positively* electrified by the silk which surrenders part of its electricity during the friction; whereas the sealing-wax is *negatively* electrified by the flannel which abstracts part of the electricity from the sealing-wax. In either case the electric fluid tends to regain its equilibrium.

(3). In accordance with the tendency of electricity to an equilibrium, we find that—

*Aphorism LVI.*

Bodies similarly electrified repel each other, and bodies dissimilarly electrified attract each other.

(1). Thus, when the feather, by contact with the positively electrified glass tube, became similarly electrified, it was repelled;—and when the negatively electrified sealing-wax was presented, the dissimilarly electrified feather was attracted, and *more* than its surplus electricity abstracted by the wax. If the glass be held in one hand, and the sealing-wax in the other, the feather will be alternately attracted and repelled from the one to the other till electrical equilibrium is restored.

(2). The two electrical states, it is obvious, must on this view, be dependent on each other,—and accordingly—

*Aphorism LVII.*

Positive electricity cannot be excited without the excitement at the same

time of negative electricity in equal degree; nor can the negative electric state be excited without the excitement at the same time of positive electricity in equal degree.

(1). Thus, when the glass tube is rubbed with silk, the hand holding the silk becomes negatively electrified in the same degree that the glass becomes positively electrified. Why the electrical state of the hand is not, in ordinary circumstances, apparent, we proceed to explain.

*Aphorism LVIII.*

There are some substances, particularly the metals, which readily conduct, or carry off, Electricity from an electrified body, while there are other substances which scarcely do so, if at all.

(1). Thus, if any positively electrified body be touched with a piece of metal held in the hand, its state is immediately changed,—the surplus electri- being carried off to the earth, because the metal and the human body are both conductors of electricity. If the excited body be touched with a glass rod, its electricity will not be carried away, because glass scarcely conducts electricity, if at all. We may now understand how the hand holding the silk, though negatively electrified when rubbing the glass tube, gives no evidence of electrical disturbance while the man stands upon the ground. His body being a conductor of electricity, an equilibrium between the electricity of his hand and that of the earth, is restored as rapidly as it is interrupted. Let him stand, however, on a plate of glass, while rubbing the tube, and then sparks will pass between his body and a finger brought near him, showing that he is in the state of electrical disturbance.

(2). On the subject of the conduction of Electricity, it is to be observed that—

*Aphorism LIX.*

The best electrics are the worst conductors.

(1). Thus glass and resin, in which the state of electrical disturbance is most readily excited by friction, are so little disposed to carry electricity to or from a body positively or negatively electrified, that they are employed as *insulators*. They are so termed because the electricity of any body placed on a plate of glass or resin is retained there,—cooped up as in an *insula* or island.

(2). Substances which readily conduct electricity are the Metals, Water, Living vegetables and Animals, Rarefied Air, &c.

(3). Substances so little disposed to conduct electricity that they are, for convenience, termed Non-conductors, are Shell-lac, Amber, Resins, Sulphur, Wax, Glass, Silk, Hair, Feathers, Dry Paper, Dry Air, Baked Wood, Porcelain.

(4). It must be here remarked that—

*Aphorism LX.*

When a body is electrified, the electricity is distributed only over the surface.

(1). For it has been found, by experiment, that a solid metallic globe cannot contain more electricity than a hollow one of the same size. The proofs of this may be found in more expanded treatises than the present compendium.

(2). We have seen that the electric state of one body affects that of another body through *conduction*; but it is not through conduction only that the electrical state of one body affects another,—for this takes place even at some distance.

*Aphorism LXI.*

Whenever an electrified substance is brought into the vicinity of substances in their natural condition, it tends to induce in them an electrical state *opposite* to its own.

(1). Thus, a substance charged with positive electricity will influence any substance near it, and induce it to have, in the part next it, the negatively electric state. This influence, to distinguish it from *conduction*, is called *induction*. Induction may take place through non-conductors, though conduction, of course, could not. For example:—take a square plate of glass, and affix on each side of it a smaller square of tinfoil. Let one of those tinfoil coatings be electrified by contact with an excited glass tube;—then, becoming positively charged, it will act, by induction, through the glass, upon the other coating. The near, or inner, surface of the second coating will be made negative, and the outer surface positive; and if the coatings are insulated, this state will continue. But if the outer side of the second tinfoil coating is connected, by some conductor, with the ground, and the positive charge is thus taken off, then the surface will have only a negative charge left, corresponding to the positive charge of the first tinfoil coating. If the two metallic surfaces be now connected by a conductor, such as a metallic wire, we then see a bright spark, and hear a sharp snap, as if a violent shock had been sent through the apparatus,—the accumulated electricity on the one metallic surface rushing along the conducting wire to supply the place of that which had been abstracted from the other metallic surface.

(2). If, instead of using a wire, any one should make the communication between the two tinfoil coatings by applying the right hand to the one, and the left hand to the other, he would experience an electric shock,—that is, a convulsive motion, in the joints and muscles, attributable to the passage of the electricity through him.

(3). If a hundred persons join hands, and the first in the chain touches the one tinfoil-coating, while the last in the chain touches the other,—every man in the chain receives the shock apparently simultaneously, as a hundred lotus-leaves are pierced apparently simultaneously by an arrow. Thence we conclude that the electricity has gone round, through the whole circuit, and that it has gone with perhaps immeasurable rapidity. It might seem as if it had been retained in a state of rigid tension, like a bow just before the discharge of the arrow, and then to have discharged itself at once. When it has gone round, observe, its influence is expended. By other arrangements, the electrical disturbance may be elicited *continuously*, as if it were renewed in a continuous *current*. This manifestation of electrical disturbance is effected chiefly by the employment of different kinds of metals in combination, as we proceed to explain.

*Aphorism LXII.*

The contact of heterogeneous metals occasions disturbance of electrical equilibrium.

(1). For example,—place a piece of zinc under the tongue, without allowing the two metals to touch each other :—no sensation will be experienced beyond the mere pressure of the two hard substances against the tongue. Let their edges now come into contact, and immediately a strong and peculiar taste will be perceived. The same sensation will be perceived, if, whilst the two metals are kept separated, a connection be made between them by means of a copper wire, with one end touching the silver and the other end touching the zinc.

(2). In a vessel containing a mixture of one part of sulphuric acid and ten of water place a plate of zinc and also a plate of copper. No electrical disturbance is manifested while they remain unconnected; but when their upper parts are connected, either directly or by the intervention of a copper wire, a multitude of bubbles of a kind of air appear at the surface of the copper. This takes place even though the connecting wire be very long.

(3). If the connection between the zinc and the copper plates be made by means of a fine wire of platinum, the wire will become ignited. Let the platinum wire connect the ends of two long copper wires,—then, on bringing the other ends into contact with the zinc and copper plates, the platinum wire will immediately be ignited as before. Thus by using copper wires of a hundred yards or more in length, we can at pleasure ignite the platinum wire at a distance of a hundred yards or more from the place where we are standing. If the platinum wire be previously inserted into a box of gunpowder, we can ignite the gunpowder, at the moment when we wish, by bringing the other ends of the long wires into contact with the zinc and copper. Since this takes place even though the box be under water, such an arrangement is very useful in removing, by the force of gunpowder, sunken wrecks, or trees, which would otherwise obstruct the navigation of a river, such as the Ganges.

(4). Wrap several coils of a long copper wire, lapped with silk, round a piece of soft iron. On bringing the ends of the wire into contact with the zinc and copper, the iron acquires the power of attracting another piece of iron. When the contact is broken, the iron loses this power; but it regains it whenever contact is again made. In other words, the iron, at the time of contact, is invested with the nature of a *magnet*.

## Section X.—Of Magnetism.

*Aphorism LXIII.*

A piece of iron ore possessing the power of attracting pieces of iron is called a natural magnet.

(1). It is called a natural magnet to distinguish it from an artificial magnet, which may be made as follows.

*Aphorism LXIV.*

By friction with a magnet a bar of iron becomes a magnet.

(2). The magnet, whether natural or artificial, does not lose any of its own power by exciting the magnetic condition in a bar of iron.

*Aphorism LXV.*

A magnetized iron bar, freely suspended by its centre, moves round un-

(1). This may be shown by suspending the bar, at its centre, by a thread; or by placing a magnetized needle gently on the surface of water, so that it may swim. The most convenient arrangement, however, is to place the centre of the bar on a pivot, so that it may be free to move round a vertical axis.

(2). Such an apparatus enables a traveller to tell the quarters of the heavens even in a starless night. It is so indispensable to navigators, when they venture out of sight of land, that it is called the Mariner's Compass.

(3). The two extremities of the magnet, since they point to the north and south poles of the earth, are called the north and south poles of the magnet.

### *Aphorism LXVI.*

Poles of the same name repel, and poles of different names attract, each other.

(1). Bring towards the north pole of a suspended magnet the north pole of a second magnet held in the hand; the north pole of the suspended magnet will fly round, giving evidence of the repulsion. The same is the case with the two south poles. But now present the north pole of the magnet in your hand to the south pole of the suspended magnet, and this pole of the suspended magnet will move round to meet it, giving evidence of the attraction. The same is the case when the south pole of the magnet in the hand is presented to the north pole of the suspended magnet.

### *Aphorism LXVII.*

A current of electricity causes a suspended magnet to point East and West instead of North and South.

(1). Take the plates of zinc and copper, immersed in diluted sulphuric acid, as directed under Aph. 72 § 2. Bend a copper wire, of two hundred yards in length, at the middle, and fix that middle part at about a hundred yards away from the vessel containing the plates. Let the middle portion of the wire be in the direction of north and south. Now place a suspended magnet close above that middle portion of the wire. The magnet will point north and south. But next bring the two ends of the wire into contact with the zinc and copper plates; and then the north pole of the magnet will instantly turn to the west. On breaking contact, the magnet immediately turns to the north again as before.

### *Aphorism LXVIII.*

The change occasioned in the direction of a suspended magnet by a current of electricity is the foundation of the Electric Telegraph.

(1). A telegraph is a contrivance for giving information quickly from a great distance. For example, when a steam-boat approaching Benares is seen by a watchman on the great minaret, the watchman displays a flag. The flag is visible to persons at a great distance; and, in consequence of the previous convention, it is the sign of an approaching steam-boat.

(2). Again, by different movements of such a flag as the one above described, different pieces of information, in accordance with previous convention, might be conveyed. For example, it might be agreed upon that

of a particular steam-boat, two such movements that of a different steam-boat, three such movements that of still a different one, and so on. Finally, as different steam-boats might be indicated by different movements previously agreed upon, of the flag, so also might the various letters of the alphabet be indicated by different movements of the flag.

(3). The foregoing is a rude illustration of the *possibility* of what is actually effected in the working of the Electric Telegraph. We are not going to discuss here the particulars of the convention according to which the movements of the magnetic bar, or needle, like the movements of the supposed flag, are made to indicate the different letters of the alphabet;—because this convention, endlessly diversible, is a matter of human arrangement, and not of Physical Science, with which alone we are now concerned. What we have here to explain is how the movements of the needle, intended by one person, and significant by convention, can become instantly known to a second person hundreds of miles distant from the first.

(4). Under Aph. 67 we have explained how a magnetic needle may be made, by means of the electric current in a copper wire, to change its direction at the wish of the person in charge of the Electromotor. Now, the instantaneousness of this change is almost independent of the length of the wires. Let the needle be at Calcutta, and let the ends of the wire which passes under the needle be at Benares,—then, on bringing the wires into contact with the electromotor at Benares, the needle at Calcutta instantly undergoes the change of direction, just as if the wires had been no more than a hundred yards in length. It will be nearly the same when Benares is united, by electric wires, with London.

(5). But it may be said,—in the case of the flag-telegraph, a person may not be looking towards the flag at the time of its being waved;—and, after two movements of it, happening to observe the final third one, he will infer that there has been only one movement;—so that he is liable to conclude wrongly in regard to the particular steam-boat whose arrival has been announced. We reply,—let a cannon be fired to call attention to the intended signals of the telegraph. But it will be said,—the firing of a cannon in Benares will not call attention in Calcutta, where the sound of that cannon cannot be heard. Well, let the person in Benares ring a bell near the ear of the person in Cacutta. How this may be done we proceed to explain.

(6). It was stated under Aph. 62 § 4, that a piece of iron, by means of an electrical current, can be made to assume the nature of a magnet,—which magnetic nature departs and returns on the breaking and again making contact of the wires with the electromotor. Let a piece of iron, suitably connected with the wire from Benares, be arranged, in Calcutta, so as to serve as the tongue of an iron bell. When contact is made, at Benares, of the wires with the electromotor, the tongue of the bell in Calcutta, becoming a magnet, is attracted towards the bell, and strikes it. Contact being broken at Benares, the tongue falls back. Contact being again made, the tongue again strikes the bell, and so on. Thus the attention of the person in Calcutta is awakened to the signals which are thereafter to be made, through the movements of the needle, from Benares.

(7). Now we mention another source of electrical disturbance.

## SECTION XI.—THERMO-ELECTRICITY.

*Aphorism LXIX.*

Heat occasions disturbance of electrical equilibrium.

(1). Place some water, in a metallic vessel, on the top of the electroscope, and drop a red-hot cinder into the water. The divergence of the indices will prove that electrical disturbance has taken place.

(2). We mention a consequence of this.

*Aphorism LXX.*

Clouds, raised by heat from water, are out of electrical equilibrium.

(1). Hence the well-known phenomena of Lightning from the clouds, the flashes, noise, stroke, &c.

(2). The identity of Lightning with Electricity has been settled by experiment. The experiment may be repeated thus. Attach one end of a very long string to the top of the electroscope, and the other end to an arrow; shoot the arrow towards a cloud floating near the earth, and the indices of the electroscope will be seen to diverge.

(3). In the movement and rest of the magnetic needle, &c., we have had particular examples of the Motion and Rest which furnish the object-matter of the present Book, viz., of Physics. But in some effects of the Imponderables we have had occasion to notice something more than mere retention of or change of *place*. For example,—on the application of heat to water, the atoms change their place in assuming the form called steam; —and on the removal of the heat, they resume the form of water. But such return of state does not occur when heat is applied to fuel. The dissipated fuel does not resume its form on the departure of the heat. It has undergone more than a physical change. It has undergone a change, to be treated of in the next Book, which change is termed *chemical.*

## SECTION XII.—ANIMAL ELECTRICITY.

*Aphorism LXXI.*

Certain animals have the power of causing an electrical disturbance.

(1). Such animals are the Torpedo (or electrical scate) of Europe, the electrical eel of America, and the Malapterurus electricus of the Ganges. This power enables them to stun their prey, and thus secure it; or to stun their assailants, and thus defend themselves.

END OF BOOK IV.

# A
# SYNOPSIS OF SCIENCE.
## BOOK V.

## INTRODUCTION.

(1). In the preceding Book, having described the Motion and Rest of external things, with their causes, their laws, and examples, we promised to describe, what are different from these, the *Chemical* changes of external things. By *change* we mean that action, on the part of substances, which leads to the attainment of a condition different from a previous condition; for example, motion towards another place, preceded by abandonment of a previous place. That certain changes are *chemical* means that they are the object-matter of the science called Chemistry, and as this statement cannot be understood without a knowledge of the nature in virtue of which these are such, we shall first declare the nature in virtue of which any changes are object-matters of the science of Chemistry.

### Section I.—Chemistry.

*Aphorism I.*

Change, other than of place, not influenced by Life, and which results in a permanent condition, is the object-matter of the science called Chemistry; and such change is called chemical.

(1). 'Permanent' &c. By the permanency of changes is meant that their surcease is not involved in the departure of their instrumental causes. For example,—the condition of ashes, &c., which is produced by fire in fuel when burned, is called permanent, because even when its instrumental cause, viz., the contact of fire, has departed, it does not surcease:—hence the behaviour of the fuel, which results in this, is a matter of chemical science. On the other hand, the condition of water as vapour, through contact with fire, departs on the departure of that contact with fire which instrumentally caused it:—therefore the action of the water which resulted therein is not a matter of Chemical science, but only of the science of motion and rest [i. e., Physics]. Hence it is to be understood that the science called Chemistry is the science of those changes only, other than of place, among external things, which result in properties not necessarily surceasing on the departure of the instrumental causes which gave rise to them.

(2). But then, when blue vitriol is dissolved in water, its hardness disappears,—and it does not return on the removal of the stirring-rod;—is

this, then, a chemical change? Not so, because the colour, taste, &c., of the blue vitriol are unchanged, and the change is only that of the place of its particles, now distributed among the particles of the water;—whereas *hardness* requires closeness among the particles.

(3). But then, when food, being digested, becomes flesh, bone, &c., is the change chemical? We reply, that as physical changes of place are involved in chemical phenomena, but the phenomena are not therefore reckoned merely physical, so chemical changes take place under the modifying agency of *Life*, and the phenomena are not then reckoned merely chemical. These phenomena belong to a subsequent and more complex science, that of Physiology.

(4). Now we make a division of the external substances which are treated of in Chemistry.

*Aphorism II.*

Bodies are Compound or Simple.

(1). A Compound body is such as vermilion, which, for example, is compounded of mercury and sulphur.

(2). That body, such as sulphur, which, so far as we can discover, is not compounded of any other bodies, we call a simple body.

(3). Compound bodies are innumerable. These are all formed out of the simple bodies, of which there are reckoned above sixty. Of these we state the divisions.

*Aphorism III.*

The Simple Bodies are divided into Metals and Non-metallic bodies.

(1). The Metals are such as Gold, Iron, Mercury &c. The Non-metallic bodies are Sulphur &c.

*Aphorism IV.*

The Non-metallic simple bodies are divided into those that are in the form of Air, and those that are not so.

(1). By an Air we mean a fluid indefinitely elastic, at ordinary temperatures and under ordinary pressure. The steam of boiling water is indefinitely elastic, but it loses its elasticity at ordinary temperatures, and this distinguishes it from Airs.

(2). Airs are divided into the common Air which we breathe and other Airs,—these latter, for the sake of distinction, being called *kinds* of Air [—or Gases].

One difference is the superior vivacity with which inflammable bodies burn in Oxygen.

(3). A piece of wood with a spark of fire just on the point of being extinguished, will commence blazing if plunged into Oxygen.

(4). Even iron burns in it like dry fuel.

(5). Phosphorus, an inflammable substance obtained from bones, burns in Oxygen with a brilliancy like that of the sun,—which is not the case when it is burned in common air.

(6). We have said that men cannot live without Oxygen. But yet men live in common air. How is this? Because there is Oxygen in common air. But if there is Oxygen in common air, why does a piece of wood with a spark not begin blazing, and why does iron not blaze when heated? It is because the Oxygen in the common air is mixed with and diluted by another gas,—viz. with Nitrogen,—which prevents this vivacity of combustion.

(7). Nitrogen, like Oxygen, has no taste, and no smell, nor can any colour be discerned in a glass vessel filled with it. What then is the difference between this gas and Oxygen? One difference is this, that an inflamed substance is extinguished when it is placed in pure Nitrogen. If, therefore, the common air had consisted of Nitrogen alone, nothing could have burned; and if it had consisted of Oxygen alone, every spark would have led to a conflagration. By the mixture of the two gases, in the proportions in which they exist in the atmosphere, both of these inconveniences are avoided.

(8). The proportion of Nitrogen to Oxygen in the atmosphere is that of four to one. This may be illustrated as follows. Place a light, so that it may float, on the surface of a vessel of water. Invert over it a large bell-glass, such as a wall-shade, so that the edge of the glass may dip a little under the water. In a little while the Oxygen will be exhausted by the combustion, the light will be extinguished, and the water will rise into the jar, showing that at least so much of the air is no longer present in its previous form.

(9). Water consists of Oxygen and of another gas which is called Hydrogen, i. e., 'the producer of water'. Hydrogen, like Oxygen and Nitrogen, has neither taste nor smell; and a glass jar filled with it appears colourless.

(10). In respect of combustion, Hydrogen is the opposite of Oxygen. A lighted taper plunged into Hydrogen is extinguished, while the Hydrogen itself takes fire.

(11). Hydrogen is the lightest of all known bodies. A balloon filled with it rises higher into the air than any bird can fly; and if the balloon is a large one it is capable of raising to that height a car containing several persons.

(12). Chlorine is a gas which differs from the other simple gases in several respects. Its colour is greenish yellow. Its odour is extremely pungent and irritating, and its taste is analogous.

(13). Several substances inflame in it spontaneously. Such are copper, in fine leaves; phosphorus; mercury heated, &c.

(14). It destroys all animal and vegetable colours, and hence it is very useful in bleaching. It also destroys the volatile products of decaying animal or vegetable substances, thus removing the offensive odour and other bad effects which are apt to arise from such a source in hospitals, prisons, &c.

*Aphorism VI.*

The Simple Non-metallic bodies which are not gaseous, are nine in number.

(1). These are named Carbon, Boron, Silicon, Sulphur, Selenium, Phosphorus, Bromine, Iodine, and Fluorine.

(2). Carbon [or charcoal] is the black substance which is left when wood is heated and the air excluded, or when the embers are extinguished by throwing water upon them.

(3). Boron is a brown powder, which is a constituent of the substance called borax.

(4). Silicon is a brown powder, which is a constituent of that hard substance, which strikes fire with steel, called flint [—or, in Latin, silex].

(5). Sulphur is a well-known inflammable yellow substance.

(6). Selenium is a rare substance which in many respects resembles sulphur.

(7). Phosphorus is a substance which in appearance resembles wax. It shines in the dark; and a degree of heat less than that of boiling water is sufficient to inflame it. As it takes fire on being rubbed, it is employed in making the matches called lucifer matches.

(8). Bromine is a dark red fluid with a very disagreeable smell [—as its name implies].

(9). Iodine is a substance of a bluish black colour with a metallic lustre. Its smell is very pungent [like that of chlorine]. When heated, it assumes the form of a vapour, which [as the name implies] is of a violet colour.

(10). The name of Fluorine is given to a supposed element in a mineral called Fluor spar.

*Aphorism VII.*

The Metals are above fifty in number.

(1). Some of these, as Gold, Silver, Copper, and Lead, are familiarly known. Of the remainder, some are very rarely met with, and need not be here described. We shall describe at present only those of the metals which it is desirable that the reader should become acquainted with.

(2). Platinum is the heaviest of the metals, being heavier even than Gold. It is white like Silver.

(3). Mercury differs from the other metals in being fluid at ordinary temperatures. In the cold air near the north pole it becomes solid, and it may then be hammered into leaves like iron or copper. When strongly heated, it rises in vapour.

(4). Tin is a metal which resembles silver in colour and lead in softness.

(5). Zinc is a metal with a leaden colour. It takes fire in the air when heated red-hot, and the product floats in the air like flocks of wool.

(6). Potassium is a metal which is so light that it swims upon water, where, at the same time, it inflames spontaneously.

(7). Sodium also floats when thrown upon water, but it does not, like Potassium, inflame.

(8). Calcium is a metal which is the basis of lime.

(9). Of the simple substances which have been now partly described, all the bodies with which we are acquainted on the earth's surface are made up.

(10). If any substance, [such as salt or chalk,] is made up of several

simple substances, it is desirable that it should have a name suggestive of its component elements.

*Aphorism VIII.*

In chemical enquiries let compound substances receive names suggestive of their component elements.

(1). For example,—common salt is a compound of Chlorine and Sodium, and its chemical name is Chloride of Sodium.

(2). Beginning with Oxygen, we shall now notice how the several Simple Bodies originate compounds.

(3). We have already stated that the atmosphere consists mainly of one part of Oxygen mingled with four parts of Nitrogen. The product of this mixture is not reckoned a chemical compound, because chemical composition is considered to have taken place, only when the qualities of the product are not what could have been predicted by taking together the properties of the separate ingredients.

(4). Of the chemical compounds of Oxygen with Nitrogen there are five. The five compounds, in the order in which we shall take them, differ from one another in having each a larger proportion of Oxygen than the one before it in the list.

(5). The first compound of Oxygen with Nitrogen is a gas which if a man breathes he laughs violently, and becomes for a time like one deranged.

(6). The second compound of Oxygen with Nitrogen is a colourless gas, which, when allowed to mingle with the atmosphere, attracts an additional quantity of Oxygen and becomes red. Charcoal and Phosphorus burn brilliantly in the second compound of Oxygen and Nitrogen; but this gas cannot be breathed, because if it were to mingle with the common air in the lungs, it would form the red gas already mentioned which is poisonous.

(7). The third compound of Oxygen and Nitrogen, which is procured with difficulty, is an acid which does not here require special notice.

(8). The fourth compound of Oxygen and Nitrogen is the red gas already mentioned. Water absorbs it readily.

(9). The fifth compound of Oxygen and Nitrogen cannot be procured separately. In combination with water it is an acid which corrodes the flesh, and dissolves iron &c.

(10). We have said that it is desirable that substances should, in chemical enquiries, be denoted by names suggestive of their component elements; but, from what has now been said of the compounds of Oxygen and Nitrogen, it must be obvious that the name ought to suggest not merely the elements but the relatively greater or lesser proportion of the elements in each compound. For example, the name of the second compound of Oxygen and Nitrogen ought to suggest its containing a greater proportion of Oxygen than the first compound.

(11). How this is effected, we proceed to explain,—premising some remarks on the various habits of various bodies in regard to their combining.

*Aphorism IX.*

In the union of some bodies no limitation is observed with regard to the relative proportions in which they unite.

(1). For example,—with a certain quantity of milk, a small quantity of water, or a large quantity of water, mingles equally well.

*Aphorism X.*

Some bodies combine in all proportions as far as a certain point, beyond which, combination no longer takes place.

(1). Thus a certain quantity of water will dissolve common salt until a certain quantity has been dissolved, after which all the salt added remains undissolved. [This kind of limitation is called Saturation].

(2). For reasons already mentioned, the two kinds of combination just described are not termed *chemical.*

*Aphorism XI.*

In chemical union bodies unite in the proportion of atom to atom, atom to two atoms, &c.

(1). This is inferred from the fact that bodies which unite chemically do so in certain fixed or definite proportions; and that when bodies unite chemically in more than one proportion, the quantity of one element in each compound is generally a simple multiple of its quantity in the first. Thus, in the five compounds of Oxygen with Nitrogen abovementioned, the proportions are those of 14 parts of Nitrogen to 8, 16, 24, 32, and 40 parts of Oxygen respectively.

*Aphorism XII.*

The weight of an atom of Hydrogen is the unit in terms of which the atomic weights of other bodies are stated.

(1). The proportions in which two elements combine with *Hydrogen* indicate the proportions in which those two elements combine also with each other. For example, 35 parts of Chlorine combine with one of Hydrogen [to form Hydrochloric acid], and 8 parts of Oxygen combine with one of Hydrogen [to form Water]; and the compounds of Chlorine with Oxygen contain 35 parts of Chlorine combined with 8, 32, 40, and 56 parts respectively of Oxygen. The numbers 8, 32, 40, and 56, we may observe, are not successive simple multiples of 8, for these would be 8, 16, 24, 32, 40, 48, 56; therefore the law under consideration [—which is called the law of Definite Proportions] suggests the probability that there are at least three different compounds of Oxygen and Chlorine yet undiscovered.

(2). Having ascertained that substances combine chemically in fixed proportions, chemists have inferred that the elementary bodies are not, like space, infinitely divisible, but that they consist of minute indivisible particles,—called Atoms.

(3). It is supposed that the Atoms, though exceedingly small, are not devoid of magnitude [—as is supposed in the Nyáya].

(4). It is also supposed that the atoms of any one element,—say of Gold, —are alike in weight, but that they differ in weight from the atoms of other elements.

(5). When bodies combine in only one proportion, it is supposed that the combination is of one atom of the one with one atom of the other; and when they combine in more proportions than one, that the combination

is of one atom of the one with one, two, three, four, &c. of the other.

(6). From this it follows that the numbers expressing the combining proportion express also the relative weights of the atoms of the combining elements. This will appear clearly if we consider that if eight pounds of one element combine with one pound of another element so as to form nine pounds of a compound substance, in which each atom of the one element is joined to an atom of the other element, then an atom of the one element must be just eight times as heavy as an atom of the other. For example, —when a galvanic current is passed through water, by placing, at a little distance from each other, in a vessel of water, the ends of the wires of the Electromotor (B. IV. Aph. LXII, 2), tipped with platinum, the water becomes separated into two gases, Oxygen and Hydrogen. If we collect the two gases separately, we find invariably that the weight of the quantity of Oxygen is eight times that of the Hydrogen. Assuming, as is most probable, that an atom of Water is formed by the union of an atom of Oxygen with one of Hydrogen, it follows that the weight of an atom of Oxygen is to that of an atom of Hydrogen as 8 to 1.

(7). Representing the weight of an atom of Hydrogen by unity, the following table exhibits the comparative atomic weights [or chemical equivalents] of the most important elements, with their symbols.

| | | | |
|---|---|---|---|
| Hydrogen 1. | H | Copper 32. | Cu* |
| Oxygen 8. | O | Iron 28. | Fe* |
| Nitrogen 14. | N | Lead 104. | Pb.* |
| Chlorine 35. | Cl | Platinum 98. | Pt |
| Carbon 6. | C | Mercury 100. | Hg* |
| Boron 20. | B | Zinc 32. | Zn |
| Sulphur 16. | S | Potassium 40. | K* |
| Silicon 22. | Si | Sodium 23. | Na* |
| Phosphorus 32. | Ph | Calcium 20. | Ca |
| Gold 98. | Au* | Magnesium 13. | Mg |
| Silver 110. | Ag* | Aluminium 14. | Al |

(8). When treating of the chemical composition of bodies it is found convenient to denote the elements by short symbols, as in Algebra. Among the symbols in use are those given in the above table.

(9). By combining the symbols of the elements we obtain the symbols of their compounds. Thus since the symbol Na stands for 23 parts of Sodium, and Cl for 35 parts of Chlorine, the symbol Na+Cl stands for 58 parts of Chloride of Sodium (or common salt). And this number 58 represents the atomic weight of Chloride of Sodium. It is 58 times as heavy as an atom of Hydrogen. The like remark applies to the atomic weights of all compounds.

(10). Having determined thus much in regard to the principles of combination, let us revert to the five compounds of Oxygen with Nitrogen. The symbolic formulæ and the atomic numerals of the five compounds of Oxygen and Nitrogen are as follows:—

* From the Latin *aurum* ;—and so of the others marked by asterisks.

| | | |
|---|---|---|
| 1st compound | $N+O$ | 22 |
| 2nd ,, | $N+2O$ | 30 |
| 3rd ,, | $N+3O$ | 38 |
| 4th ,, | $N+4O$ | 46 |
| 5th ,, | $N+5O$ | 54 |

(11). An inspection of these symbols will show that, in these five compounds there is such a difference in the relative proportions of the elements as will require to be suggested by the chemical name of the compound. But there is another consideration which prevents us from giving to the five a set of names suggestive of nothing more than this distinction. For example, some of the compounds of Oxygen with Nitrogen are *acid*, and others are not. This difference being a very important one, it requires to be recorded in the name of the compound; and, with reference to this, we propound the following aphorism.

*Aphorism XIII.*

Compounds of the elements ought to have names suggestive of the fact that they are *acid* or otherwise.

(1). Of the five compounds of Oxygen and Nitrogen three are *not* acid, and these, accordingly, are named, simply with reference to their having respectively the first, the second, or the third and greatest proportion of Oxygen, as follows.

The Protoxide of Nitrogen,
The Deutoxide of Nitrogen.
The Peroxide of Nitrogen.

(2). Of the compounds of Oxygen and Nitrogen the remaining two are acids. Let us consider how these are to be distinguished. When any substance, by combining with two different proportions of Oxygen, is capable of forming two distinct acids, that acid which contains the larger proportion of Oxygen is distinguished by the syllable *ic* at the termination of its name, and the other, containing the lesser proportion of Oxygen, is distinguished by the termination *ous*. Accordingly the third and fifth compounds of Nitrogen and Oxygen, which are acids, are respectively named Nitrous acid and Nitric acid. The names of the five compounds of Oxygen with Nitrogen are therefore as follows.

1 Protoxide of Nitrogen.
2 Deutoxide of Nitrogen.
3 Nitrous acid.
4 Peroxide of Nitrogen.
5 Nitric acid.

(3). Having considered the compounds of Oxygen and Nitrogen with one another, we now turn to Hydrogen,—and enquire what compounds it forms with these two elements.

(4). Hydrogen and Oxygen, atom to atom, produce water. The symbol of water accordingly is H+O, and its atomic numeral 9.

(5). Hydrogen combining with Nitrogen produces Ammonia, a gas with a very pungent odour. This gas eagerly combines with water. In Ammonia there are three atoms of Hydrogen to one of Nitrogen, so that its symbol is 3 H+N, and its atomic numeral 17.

(6). Chlorine, the fourth in our list, combines with Oxygen, with Nitrogen, and with Hydrogen, forming a variety of compounds, among which we shall notice at present only that with Hydrogen. This Compound is a pungent acid gas, termed Hydro-chloric Acid, which unites eagerly with water. Its symbol is Cl+H, and its atomic weight 36.

(7). We have next to consider the combination of the second class of elements,—those which are neither metals nor gases,—with the elements of the first class.

(8). Carbon, in combination with Oxygen, produces an acid gas, Carbonic Acid. This gas is fatal to animal life. It is so heavy that it may be poured from one vessel into another like water. Hence, in some wells and caverns where it is formed naturally, it occupies the lower parts, whilst the upper parts are free from it; and in the same place, therefore, where a dog is killed by it, a man, from his superior height, is unhurt. The symbol of Carbonic Acid is C+2 O, there being two atoms of Oxygen to one of Carbon. Its atomic weight is 22.

(9). When a diamond is burned in Oxygen gas, the result is Carbonic Acid. This shows that the diamond consists of Carbon.

(10). Carbon with Nitrogen produces an inflammable gas with a penetrating and peculiar smell,—the Carburet of Nitrogen.

(11). With Hydrogen Carbon forms an inflammable gas, Carburet of Hydrogen,—which may frequently be obtained from stagnant pools by stirring the mud. This gas in some places, as at Jwálámukhí in the Panjáb, issues from the ground in such quantities that it can supply a continual flame. A gas of this kind may be extracted from coal. In Europe it is employed to light up the streets.

(12). Sulphur, combined with three atoms of Oxygen, produces Sulphuric Acid, a gas which readily unites with water. Its symbol is S+3 O, and its atomic weight 40.

(13). Phosphorus, combined with five atoms of Oxygen, forms Phosphoric Acid. Its symbol is Ph+5 O, and its atomic weight 72.

(14). Phosphorus combined with Hydrogen produces a gas which inflames spontaneously in the air. It is named Phosphoretted Hydrogen.

(15). We have now to consider the combination of Metals, the elements of the third class, with those of the other classes and with one another.

(16). The combinations of most metals with Oxygen are commonly termed *rusts*. Gold and Silver have very little disposition to combine with Oxygen. They do not *rust*; and this is one reason why they are well adapted for making coins &c.

(17). The Common red Oxide, or rust, of Iron consists of two atoms of Iron to three of Oxygen. This ratio being that of 1 to $1\frac{1}{2}$, the red rust of iron is called the Sesqui-Oxide* of Iron.—Its symbol is 2 Fe+3 O, and its atomic weight 40. There is a Protoxide of Iron, the symbol of which

* From the Latin prefix *Sesqui*, signifying half as much more.

is $Fe+O$, and the atomic weight 36. The sparks that fly off from a mass of hot iron, when hammered by the blacksmith, consist of this Oxide.

(18). Of Lead the Protoxide (litharge) is yellow, and the Deutoxide (minium) is red.

19). The Peroxide of Mercury is of a red colour. With Chlorine Mercury forms two compounds The Proto-chloride of Mercury (calomel), a tasteless white powder, is a valuable medicine. The Perchloride of Mercury (corrosive sublimate) is highly poisonous.

(20). With Sulphur, as already mentioned, Mercury forms a brilliant red powder—the Bisulphuret of Mercury (vermilion).

(21). Mercury combines readily, in a cold state, with several of the metals. Combined with gold it is employed in gilding vessels of silver.

(22). The Oxide of Potassium, called Potassa, is a white substance with an intensely acrid (alkaline) taste. It corrodes the flesh.

(23). The Oxide of Sodium, called Soda, very much resembles that of Potassium.

(24). With Chlorine, Sodium forms common salt. The symbol of Chloride of Sodium (common salt) is $Na+Cl$, and the atomic weight 58.

(25). The Oxide of Calcium is commonly called lime.

(26). Having now considered the *binary* compounds,—those into which only two elements enter,—we have next to consider those compounds into which a greater number of elements enter. In Aph. 13 the distinction between Acids and other compounds has been adverted to. One distinction which belongs to most acids, as is implied in the name, is a sour taste. Another characteristic, or *test*, is this, that they change a vegetable blue infusion, such as that of the Hibiscus flower, to red. Among the binary compounds there are others which, like Potassa, have an acrid taste [and which are termed *alkalis*], which restore the blue colour to the infusion, or which go further and change it to green. With these alkalis, as well as with other oxides, the acids are disposed to form further compounds, in regard to which we remark as follows.

*Aphorism XIV.*

Acids combine with Oxides to form Salts.

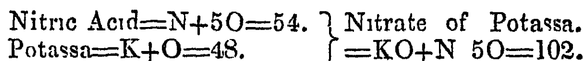
(1). It has already been mentioned that common salt is a compound of Chlorine and Sodium; so that it is not now asserted that *all* salts are compounds of acids and oxides, but only that very many are so; and of these we now proceed to give some account.

(2). Acids as already mentioned have names ending in *ic* or *ous*. In the name of the salt the *ic* is changed to to *ate*, and the *ous* to *ite*. Thus a salt into which Nitric Acid enters is called a Nitrate, and one into which Nitrous Acid enters, a Nitrite.

(3). As it is always with the *Oxides* of the metals that the Acids enter into combination, it is not necessary to notice this in naming the salt, unless when more than one oxide of the same metal combines with acids. Thus, instead of Nitrate of the Oxide of Silver, it is sufficient to say Nitrate of Silver; but we must distinguish between the Sulphate of the Protoxide of Iron, and the Sulphate of the Sesquioxide of Iron.

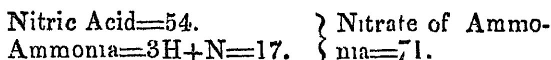
(4). In the following list, the Acid and Oxide in each case is mentioned in the left hand column, with the respective symbols and atomic weights, and the resulting symbol and atomic weight in the right hand column.

*Nitrate of Potassa.*


Nitric Acid=N+5O=54. } Nitrate of Potassa.
Potassa=K+O=48. } =KO+N 5O=102.

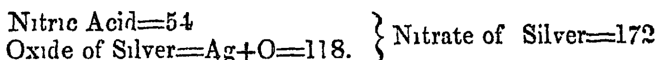
Nitrate of Potassa is the well known salt, commonly called Nitre or Saltpetre, which is employed in the manufacture of gunpowder.

*Nitrate of Ammonia.*


Nitric Acid=54. } Nitrate of Ammo-
Ammonia=3H+N=17. } nia=71.

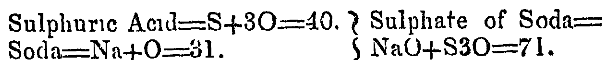
Nitrate of Ammonia is employed in the preparation of the Protoxide of Nitrogen, the gas which intoxicates one who breathes it.

*Nitrate of Silver.*


Nitric Acid=54
Oxide of Silver=Ag+O=118. } Nitrate of Silver=172

This salt is employed by medical men as a caustic: [—lunar caustic].

*Sulphate of Soda.*


Sulphuric Acid=S+3O=40. } Sulphate of Soda=
Soda=Na+O=31. } NaO+S3O=71.

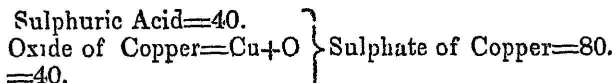
Sulphate of Soda is one of the salts employed in the galvanic battery.

*Sulphate of Lime.*


Sulphuric Acid=40.
Lime=Ca+O=28. } Sulphate of Lime=68.

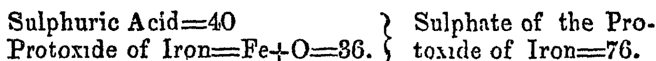
Sulphate of Lime [—commonly called Plaster of Paris—] is white like chalk. It is much employed in making statues by means of a mould.

*Sulphate of Copper.*


Sulphuric Acid=40.
Oxide of Copper=Cu+O } Sulphate of Copper=80.
=40.

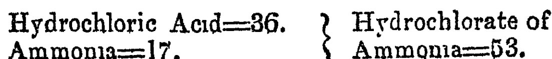
Sulphate of Copper [—commonly called blue vitriol—] is a well-known salt which is employed in the galvanic battery.

*Sulphate of Iron.*


Sulphuric Acid=40 } Sulphate of the Pro-
Protoxide of Iron=Fe+O=36. } toxide of Iron=76.

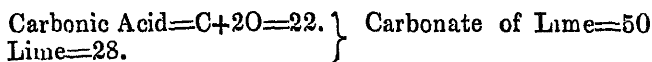
This salt, being of a green colour, is commonly called green vitriol.

*Hydrochlorate of Ammonia.*


Hydrochloric Acid=36. } Hydrochlorate of
Ammonia=17. } Ammonia=53.

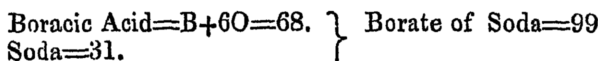
This salt, commonly known as Sal Ammoniac, is employed in cooling water, and for many other purposes.

*Carbonate of Lime.*



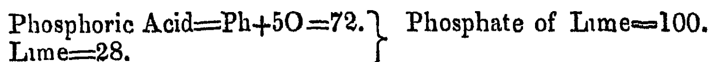

The substance commonly known as Chalk, is a Carbonate of Lime.

*Borate of Soda.*




This salt is the substance well known as Borax.

*Phosphate of Lime.*




This salt is the principal ingredient in the bones of men and other animals.

(5). Thus far we have been engaged in tracing the Elements through their successive combinations until we arrive at some of the well-known compound substances which men daily make use of. The production of a substance by the combination of the proper ingredients is called *Synthesis*.* The converse process, where we decompose a compound in order to determine what are its constituent elements, is called *Analysis*.†

*Aphorism XV.*

The analysis of Chemical compounds is effected by Heat, by Electricity, or by the introduction of some substance having a stronger attraction for one of the united substances than these have for each other.

(1). For example, the red Oxide of Mercury, when heated, is resolved into metallic Mercury and Oxygen gas. This furnishes one means of procuring Oxygen in a separate state.

(2). Water is decomposed by Electricity into Hydrogen and Oxygen.

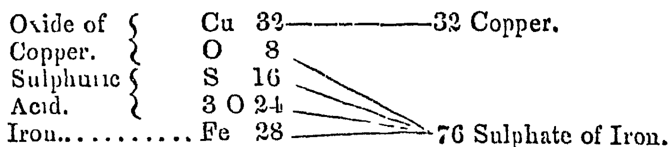
(3). Sulphate of Copper [the *tútiyá* or blue vitriol of the bázárs] may be decomposed by dipping a polished piece of iron into a solution of the salt. The acid, having a stronger attraction for the iron than for the copper, unites with the iron, and deposits the copper on its surface. When the whole of the copper has been deposited, the solution will be found to consist of Sulphate of Iron [the *kasís* or green vitriol of the bázárs].

(4). The comparative attractions of various substances, having been first ascertained by experiment, have been registered by chemical enquirers in tables, by referring to which we learn what substances to employ in decomposing any compound body.

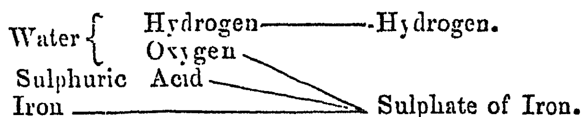
* From a Greek word signifying "to put together."
† From a Greek word signifying "to unloose."

(5). The Atomic number of any substance is also called its *equivalent* number, because it indicates the proportional number of pounds or ounces of the substance which are exactly sufficient to supply the place of another substance in a compound. Thus, in the experiment cited above, if there were 31 ounces of copper in the solution of blue vitriol, it would be found that 28 ounces of iron were sufficient to supply the place of the copper, or, in other words, that the acid which had dissolved 31 ounces of copper, could dissolve no more than 28 ounces of iron. The powers of saturation of iron and copper have thus been experimentally ascertained to be in the ratio of 28 to 31, as is recorded in the table of atomic weights. A knowledge of the equivalent numbers saves the chemist from all doubt as to the exact quantity of any substance which is necessary to effect any proposed composition or decomposition.

(6). Substituting the symbols for the names of the Sulphate of Copper and of the Iron, the result of the decomposition may be concisely expressed as follows.



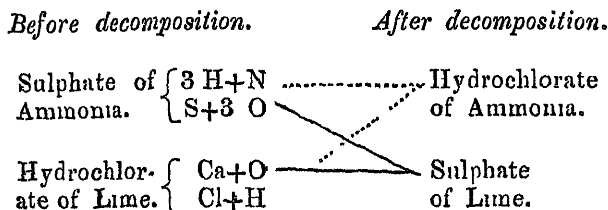

(7). It will be observed that, in accordance with the principle of Chemical Equivalents, the quantity of Oxygen that was required to make the 32 parts of Copper in the salt into an Oxide, is just the quantity that is required to make the 28 parts of Iron into an Oxide. If the Iron, instead of being dipped into a solution of Sulphate of Copper, be immersed in a watery solution of Sulphuric Acid, then, in order to combine with the acid, it takes the necessary supply of Oxygen from the *water*. The consequence is that the Hydrogen of the water is set free, and comes away in the shape of bubbles. This decomposition may be illustrated as follows.




This furnishes one means of procuring Hydrogen in its separate state.

(8). In the foregoing examples one out of three substances, by taking possession of the second, turns the third adrift. In certain cases of decomposition there are four substances forming two compounds, which two, on meeting, make a mutual exchange of an ingredient. For example, let the Hydrochlorate of Lime dissolved in water, be mixed with a solution of Sulphate of Ammonia:—the Sulphuric Acid will combine with the Lime, and Hydrochloric Acid, instead of flying off (as it would have done if Sulphuric Acid alone had been added) combines with the Ammonia which the Sulphuric Acid had deserted. This may be represented as follows,—the conti-

nuous lines showing the direction of the one pair of ingredients from left to right, and the dotted lines the direction of the other pair.




(9). Having given some account of the science of Chemistry, we may be asked—in what shape do the substances, simple or compound, with which this science is conversant, present themselves in the world? We reply,—that they present themselves in two shapes, (1) as inorganic and (2) as organic. Since organic bodies are resolvable into inorganic substances, being differenced from these by the agency of Life, the consideration of which belongs to a subsequent section, we now give some account of inorganic substances as they are found in nature. Since many of these are dug out of mines, inorganic substances are here denominated *minerals*.

## Section II.—Mineralogy.

### *Aphorism XVI.*

Minerals are of two kinds, homogeneous and mixed.

(1). Of these the homogeneous are those which are of similar composition throughout, and the mixed are those which are not of similar composition throughout. The substance similar throughout may be *chemically* simple or chemically compound;—e. g., diamond and quartz-crystal.

(2). It is the same thing whether we examine a large or a small mass of any homogeneous or simple mineral; in either case it presents to us the same structure. A small specimen of chalk gives us as good an idea of the properties of chalk as would be given by a large block or a mountain of the same material.

(3). Mixed minerals being mixtures of the simple minerals, the simple minerals must therefore be first examined.

### *Aphorism XVII.*

In recognizing the simple minerals, we are guided by their form, and other characteristics.

(1). Many minerals crystallise in determinate forms. These forms are very numerous. We cannot here mention all the forms of crystals, for fear of prolixity. They are described fully in special works on this branch of science,—which is termed Crystallography.

(2). Crystals are seldom quite regular. It may generally be assumed that there were obstacles present at the instant of their formation, which did not permit the crystal to be equally and perfectly developed upon all sides. But this need not prevent our recognising the form.

(3). The determination of a mineral is much aided by attending to its specific gravity, its hardness, &c. Of two minerals, that one is the hardest which will scratch the other without being scratched itself. A scale of hardness has been constructed, by means of ten well-known minerals, so arranged that each one will scratch that which precedes it, and may itself be scratched by all those which follow it in the scale. Thus we speak of ten degrees of hardness, which belong to the following minerals:—

| | |
|---|---|
| 1=Talc. | 6=Felspar. |
| 2=Gypsum. | 7=Quartz. |
| 3=Calcareous spar. | 8=Topaz. |
| 4=Fluor spar. | 9=Corundum. |
| 5=Apatite. | 10=Diamond. |

If, therefore, we are told that the degree of hardness of a certain mineral is 7, we known that it is meant that the hardness is equal to that of quartz.

(4). In the case of transparent crystals, the *refractive power* serves also as a characteristic. The precious stones, such as the diamond, are highly refractive. Some crystals not only refract the incident ray, but divide it into two parts, each proceeding in a different direction, so that two images are seen of any object, such as a black line, when viewed in a certain direction through the crystal.

(5) Finally, when considerations of form, &c., fail to determine the mineral, Chemistry comes to our aid.

*Aphorism XVIII.*

Minerals are chemically examined by means of the decomposing power of heat, and that of acids.

(1). Heat, in the examination of minerals, is usually applied by means of the blowpipe. The *colour of the blowpipe flame*, on a mineral, is often an excellent means of distinguishing it. Thus Soda imparts to the flame a yellow tint, Copper a green, &c. By the application of hydro-chloric acid we may ascertain the presence of carbonic acid, which it liberates with effervescence, e. g., from chalk.

(2) Now, following the classification of the Elements and their compounds, as set forth in the section of Chemistry, we proceed to describe some of the minerals, in the order of our list, viz. Carbon, Sulphur, &c.

*Aphorism XIX.*

Simple minerals are the Diamond, &c.

(1). The diamond consists entirely of carbon. It is the hardest and the most valuable of stones. It crystallises in octohedrons or in some allied form. Carbon uncrystallised, appears as Coal, &c.

(2). Sulphur occurs in nature, in rhombic octohedrons, but more frequently in an uncrystalline state.

(3). Gold assumes several crystalline forms, but is more usually found in irregular masses and grains.

(4). Silver occurs pure in cubical crystals; but is more usually associated with other metals, and with sulphur

(5). Native copper is rarely crystalline, but is usually arborescent. Carbonate of copper (Malachite) crystallises in oblique rhombic prisms of an emerald-green colour.

(6) Iron rarely occurs native, but is usually combined with Oxygen, or Carbonic Acid Sulphuret of Iron crystallizes in pentagonal dodecahedrons of a brilliant yellow colour.

(7). Lead occurs usually combined with Sulphur. The Sulphuret of Lead crystallizes in cubes, of a lustrous grey colour.

(8). Platinum occurs sometimes in cubical crystals, but more usually in nodular pieces and grains.

(9). Mercury occurs native, but more usually in combination with Sulphur, as Cinnabar. Cinnabar has a carmine colour. It becomes black on being heated, but resumes its red colour on cooling.

(10). Zinc occurs as a sulphuret. The Sulphuret of Zinc crystallises in cubes and other forms. Its colour is green, yellow, red, &c.

(11). Potassium occurs combined with Nitric Acid, in Nitre, which crystallises in rhombic prisms, often like needles.

(12). Sodium, combined with Chlorine, occurs in cubes, or in tabular masses. This is Rock-salt.

(13). Calcium occurs in marble, chalk, *kankar*, &c., in combination with Carbonic Acid. Crystallized in rhombohedral plates, it possesses in a high degree the power of double refraction. This is very observable in Iceland spar.

(14). Silicium is the basis of Quartz, which consists of Silicic Acid. It occurs in six-sided prisms terminated by pyramids. It occurs also in uncrystallised masses. It is either transparent or white. It is very hard, and produces sparks with steel. From the admixture of other substances, it occurs of various colours. Amethyst, flint, jasper, agate, &c., are various kinds of coloured quartz.

(15). Magnesium, combined with Silicic Acid, forms Talc, a smooth soft translucent substance, readily separable into unelastic laminae. Augite contains the same ingredients, along with other matters which give it greater hardness and a deeper colour. A variety of this (Hornblende), of nearly similar chemical composition, sometimes crystallises in exceedingly fine needles (Asbestos). These, being flexible, can be mixed with flax and woven into cloth, from which the flax may then be removed by burning. An incombustible cloth can be thus prepared. The dead bodies of the rich were, in ancient times, enveloped in such garments, and then burned, by which means the ashes of the body were kept separate from those of the pile.

(16). Aluminium is the basis of Corundum, which consists of Alumina, or pure oxide of Aluminium. Sapphire, Ruby, Emerald, and Topaz, are varieties of this. Felspar is a Silicate of Alumina, combined with Silicate of Potassa. It frequently occurs in crystals of a pink colour. Mica, which generally appears in soft thin laminae, of pearly lustre, consists of Silica and Alumina, frequently combined with Magnesia. Its elasticity distinguishes it from Talc. There is a variety of Sand-stone, to which the admixture of Mica imparts a curious degree of flexibility.

(17). Now we have to describe some of the more important mixed minerals, or rocks, which consist of mixtures of the simple minerals.

*Aphorism XX.*

Mixed rocks are Gneiss, &c.

(1) Gneiss is a mixture of quartz, mica, and felspar. The quartz and felspar form granular layers, separated by laminæ of mica.

(2). Mica-slate is a distinct mixture of mica and quartz in alternate layers.

(3). Clay-slate is an indistinct mixture of particles of mica, quartz, felspar, talc, &c. Its colour is greenish grey, &c.

(4) Granite has the same constituents as gneiss, but the mica does not lie in parallel laminae, so that the appearance is not slaty but granular.

(5). Basalt is generally an indistinct mixture of augite and felspar.

(6) Lava differs from augite in being less compact

(7). Sandstone consists of minute particles of quartz held together by a very small portion of clay, or other uniting medium.

(8). Clay is a mixture of alumina with a little lime and silica It softens in water, and is easily moulded. Thus it is useful to the potter.

(9). Humus, i. e, cultivable soil, is the superficial stratum of the earth's crust. It is the product of animal and vegetable matter in combination with the dust yielded by the disintegration of various rocks.

(10). In the section on Chemistry we considered various products of the elements which can be reproduced, by means at our disposal after their elements have been separated. The red Oxide of Mercury, for example, may be separated into Mercury and Oxygen, and we can very easily cause the Mercury to recombine with Oxygen and to reappear in the form of the red Oxide. It is otherwise, however, with certain other substances We can decompose a piece of wood, and ascertain that it consists of Oxygen, Hydrogen, and Carbon, and we can decompose a piece of flesh, and ascertain that it consists of Oxygen, Hydrogen, Carbon, and Nitrogen, but we cannot, out of these elements, reproduce, in our laboratories, either wood or flesh. To the reproduction of these another principle is indispensable, viz., *life*. Things that have life are vegetables or animals.

## SECTION III —VEGETABLE PHYSIOLOGY.

*Aphorism XXI.*

The principle of Life modifies chemical action.

(1). A seed of a plant, placed in the earth, produces changes in the matter taken up into the plant which cannot be imitated by art. For example, the seed of the Madder developes a well-known colour which can be derived from no other source; and the seed of a Mango produces a fruit the flavour of which is equally inimitable.

(2). Let us now consider the order in which a plant is developed from a seed.

*Aphorism XXII.*

A seed, being placed in the ground, in due time sends forth two shoots, one ascending and forming the stem, and the other descending and forming the root.

(1). When the shoot appears above ground it shows a strong desire—if

we may so term it—for light. If the light be excluded, the plant languishes, and the leaves do not acquire their green colour. If light be admitted by a small opening, the plant will incline towards the opening.

*Aphorism XXIII*

The food of plants is derived from the earth by the root, and from the air by the leaves.

(1) It has been already mentioned that the substance of plants consists chiefly of Oxygen, Hydrogen, and Carbon. Oxygen and Hydrogen may be supplied by water, and every one knows how necessary it is for plants to be furnished with water, which they take in by their roots.

(2). From the air plants derive Carbon. Carbon exists in the air, in combination with Oxygen, in the shape of Carbonic Acid gas. This gas is produced in large quantities by the breathing of animals, as well as from other sources.

(3). To show that Carbonic Acid exists in the air exhaled from the lungs, breathe, through a tube, into a transparent solution of Lime in water. The lime-water will become turbid, the lime being converted into Carbonate of Lime, or chalk, which is insoluble in water.

*Aphorism XXIV.*

The leaves perform for the plant the functions of the stomach and lungs of animals.

(1). The stomach of an animal separates the nutritious portions from the food, and rejects the remainder. The leaves of plants do the same. Thus, Carbon being required in a solid shape to form the stem and branches of the plant, it is separated from the Carbonic Acid of the atmosphere by the leaves, and the Oxygen of the Carbonic Acid is rejected.

(2). Thus we find that animals exhale a gas which, in large quantity, is poisonous to animals, but which is necessary to plants; and plants in return inhale this gas, and exhale the Oxygen which is indispensable to animals.

(3). We have seen the proof that Carbonic Acid gas is exhaled by animals. Let us now see the proof that Oxygen gas is exhaled by plants.

(4). Place a handful of fresh leaves under a large glass vessel quite filled with water and inverted in another vessel of water. Expose the whole to the light of the sun, and the leaves will give out Oxygen, which may be recognised by its chemical properties already described.

(5) Of the thread-like fibres seen in flowers, some, called the *stamens*, are male; the others, called the *pistils*, are female. Those on the top of which there is a kind of powder or dust, are the stamens, the others are the pistils.

(6). When the dust from the stamens falls upon the pistil, then the plant bears seed, but not otherwise. Hence, if the stamens of the blossom be removed, no fruit will be produced. But if, after the removal of the stamens from a flower, the dust from the stamens of a plant of a kindred species be sprinkled over the pistil, then the seeds produced will partake of the qualities of both. By this means new varieties of flowers have been produced.

(7). In some kinds of trees the flowers on one tree contain stamens only, and on another pistils only. The former may be called male trees, the latter female. The male trees bear no fruit, and are commonly called bar-

ren. The reason of their barrenness is obvious from what has been said. The female trees bear fruit when they are planted near the males, as in the case of the date tree and the like.

(8). Let us now consider, as ancillary to Vegetable Physiology, the classification of plants.

### Section IV —Botany.

(9). Plants are regarded first under the following division.

*Aphorism XXV.*

Plants either have visible flowers, or they have not.

(1). Among the plants which have no visible flowers are the mushrooms. Plants with visible flowers are such as the Mango-tree, &c.

(2). The *Ficus religiosa* and other fig-trees are not to be reckoned among plants with invisible flowers, because their flowers, inside of the fruit, are visible by the aid of a microscope.

(3). Flowering plants are first classified according to the number of their stamens. These classes are again sub-divided according to the number of the pistils; and the species of the plant is determined by the form of the leaves and other characteristics.

(4). Plants, though they have life, have neither sensation nor the power of locomotion. This distinguishes them from animals.

(5). Let us now consider the bodies of animals,—and first of the human body.

### Section V.—Animal Physiology.

*Aphorism XXVI.*

The parts of the human body are the skeleton, the muscles, the brain, the stomach, the heart, the lungs, the blood-vessels, &c.

(1). The human skeleton consists of 254 bones.

(2). The muscles constitute the bulk of what is commonly called the flesh. At the impulse of the will these are shortened or lengthened, and thus they move the bones of the skeleton to which they are attached.

(3). The mass of the brain is located in the scull. Its substance, extending downwards through the spinal column, is distributed in small branches, called nerves, to most parts of the body. Where these do not extend, as into the hair or the nails, there is neither sensation nor voluntary motion.

(4). The food eaten is divided by the stomach into what is useful and what is not.

(5). The digested food [in the shape in which it is called chyle] is carried to the heart by a channel [called the left subclavian vein]. Here it mixes with, and reinforces, the blood, which is the medium by which all the parts of the body, solid or fluid, are supplied with nourishment.

(6). From the heart, by its constant action, the blood is forced, through the arteries, into the lungs, and afterwards throughout the body,—returning to the heart through the veins.

(7). In the lungs the blood absorbs Oxygen, and parts with Carbon, as has been already noticed when treating of plants,—which, on the contrary, absorb Carbon and part with Oxygen.

(8). We have now to consider, as ancillary to Animal Physiology, the classification of animals.

## Section VI —Zoology

### *Aphorism XXVII.*

The animal kingdom is divided into four provinces,—viz., the *Vertebrata*, the *Mollusca*, the *Articulata*, and the *Radiata*.

(1). The first division, or sub-kingdom, that of the *Vertebrata*, consists of the animals possessing a spine, as man. The second division, that of the *Mollusca*, consists of animals with very soft bodies, many of which have shells, as the snails. The third division, that of the *Articulata*, consists of animals with jointed bodies, like the centipede. The fourth division, that of the *Radiata*, consists of animals whose members are symmetrically disposed around a centre, as in the starfish, the sponge, and many of the *animalcula*, discernible only by the aid of the microscope, which swarm in stagnant water.

(2). Of the first division, the *Vertebrata*, there are four sub-divisions or classes. The first is that of the *Mammalia*, or animals which give suck; the second, of the *Aves*, or Birds; the third, of the *Reptilia*, or Reptiles; and the fourth, of the *Pisces* or *Fishes*.

(3). Of the *Mammalia*, again, there are twelve sub-divisions or orders. The order *Bimana*, or two-handed, includes man alone; the *Quadrumana*, or four-handed, are the monkeys; the *Cheiroptera*, or hand-winged, are the bats. The *Insectivora*, or eaters of insects, include the musk-rat; the *Carnivora*, or eaters of flesh, the tiger; the *Cetacea*, or animals like the whale, the porpoise of the Ganges; the *Pachydermata*, or animals with thick skins, the elephant, the *Ruminantia*, or those that chew the cud, the ox; the *Edentata*, or animals with few or no teeth, the pangolin; the *Rodentia*, or gnawing animals, the mouse; the *Marsupiata*, or animals with a pouch, the Kangaroo; and the *Monotremata*, the Ornithorhyncus, or duck-billed quadruped of Australia.

(4). Like the *Vertebrata*, the three other great divisions of the animal kingdom contain many sub-divisions which cannot here be detailed.

(5). Here ends the Fifth Book of the Synopsis of Science,—the consideration of Chemical and Vital agencies.

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# A
# SYNOPSIS OF SCIENCE,
## BOOK VI.

GEOLOGY AND PHYSICAL GEOGRAPHY.

## INTRODUCTION.

(1). Now we have to speak of the causes of the structure and arrangement which belong to rocks, and of the distribution of plants and animals throughout the earth.

### SECTION I.—GEOLOGY.

*Aphorism I.*

Rocks are either tabular in their structure, or not so.

(1). Rocks arranged in tabular forms, or strata, frequently afford peculiar evidence that the several strata did not originate simultaneously, but that their deposition and solidification took place gradually and successively. Suppose that, in the bed of the Ganges, some miles beneath the mouth of the Sone, a bed of mud had been deposited by the Ganges, and that then the flood of the Ganges subsided, and that of the Sone brought down and deposited on the mud a layer of sand, and that then the flood of the Sone abated, and the Ganges deposited a layer of mud above the sand,—it is evident that the three layers must have been deposited at successive times. Now, if the Ganges cuts away a lateral portion of the supposed bed, the three layers will be exposed to view; and an observer can entertain little doubt that the lowest layer was the first deposited, and so of the others; just as the lowest layer of bricks in a wall is the first deposited, and so of the rest.

(2). In accordance with this principle, the relative superposition of stratified rocks has been examined by Geologists, wherever this was practicable, all over the world. Omitting the less important rocks, which are mentioned in fuller treatises, the order of superposition, beginning from the lowest and earliest rock, is as follows.

*Aphorism II.*

Gneiss, mica-slate, clay-slate, grey-wacke, old red sandstone, mountain-limestone, coal-beds, new red sand-stone, chalk, plastic clays, gravel, vegetable soil, are the chief stratified rocks.

(1). Since many of these layers are many hundred feet in thickness, we should probably never have been made acquainted with the lower members, if all had retained the horizontal position in which we must suppose them to have been first deposited. But they have by no means everywhere retained this horizontal position. Instead of retaining their horizontal arrangement, like bricks piled one above another, they are found in a sloping position, like such a pile of bricks which has been pushed to one side,—or in a vertical position, like the pile of bricks turned up on their edges,—or contorted in various ways.

(2). Seeing these disarrangements, which we are led by analogy to attribute to the operation of violent forces, we have next to enquire whether any forces are at present in operation such as are adapted to the production of such disarrangements. Observing the existence of burning mountains, and of hot springs, we are led to make enquiry; and we eventually arrive at the following result:—

*Aphorism III.*

Though the temperature of the ground, at the surface, caused by the sun's heat, differs in different countries, yet at less than 100 feet below the surface the temperature in everywhere the same; and below that point the temperature everywhere increases with the depth, so rapidly that the interior of the globe must be in a state of fusion.

(1). This internal heat, we conclude, is the cause of volcanoes, hot springs, &c.

(2). It appears probable that there was a time when the whole globe was one liquid glowing mass. The waters must at that time have been in the form of steam, and no animals or vegetables could have existed on the earth. When the earth cooled, by the radiation of its heat into infinite space, a crust would form over it, as we see in the cooling of molten lead. As the cooling proceeded, the watery vapour would settle down in a liquid form.

(3). Under these circumstances as it might appear at first sight that the earth should have been uniformly spherical. But, as we see a parched clay soil, as in the bed of the Ganges, split, as it hardens and contracts, into rents and fissures, so we may suppose the cooling crust of the earth to have done. The water, entering those fissures, and widening them more and more by its solvent power, would penetrate at last though the thin crust to the still glowing interior mass. The result of the sudden contact of a large body of water with a red hot surface would be the formation of a vast body of steam. The steam, being enormously expansive, would press in every direction with irresistible force, raising the crust of the earth here and there, and puffing it up into large vesicles, as a child blows soap-bubbles in a dish. Where these broke, the liquid mass within, forced out by the steam, would pour out upon the surface, and harden there. Thus, we may conceive, were the first high grounds or mountains formed on the surface.

(4). The tops of high mountains, as already mentioned are cold, as is proved by the perpetual presence of snow upon them, as in the Himálaya. The snows of lofty mountains are the sources of great rivers, as the Ganges. Great rivers carry down quantities of solid matter, abraded from the mountains, and deposit this in the lower grounds. Thus have the Sundarbans

been formed by the Ganges. If we find portions of palmtrees, and bones of crocodiles, tigers, deer &c., embedded in the strata of the Sundarbans, we are not surprised, because we know that these strata consist of what was originally abraded and softened matter carried downwards by the river, whilst palmtrees grew, and tigers, &c., lived, in the vicinity. So, conversely, when we find the remains of plants and animals in the stratified rocks of which we have been now speaking, it seems reasonable to conclude that those rocks were once dissolved through water, just like the mud that formed the Sundarbans, and that the plants and animals, the remains of which we find preserved in the rocks, lived at the time when those rocks were forming.

(5). Many of the plants and animals whose remains are found in hardened rocks, were of very strange kinds. Anatomists can sometimes recognise the species of an animal by means of a single bone; how much more so, then, when entire skeletons have been discovered. We shall describe very briefly some of the animals which, from an examination of their skeletons embedded in rocks, have been ascertained to have existed on this globe at the period when those rocks were formed. The Mammoth, the elephant of the ancient world, was about 9 feet high, and above 16 feet long from the point of the nose to the end of the tail. Its tusks were nine feet and a half in length, and were very much curved. Its body was covered with hair. The Megalosaurus, or alligator of the ancient world, was between 40 and 50 feet in length. Its bones are found in England, a country which is now too cold for alligators. The Iguanodon, or gigantic iguana, a kind of long-tailed lizard, grew to above 70 feet long. The Ichthyosaurus, or fish-lizard, must have resembled an alligator with fins instead of feet. The largest species was about 20 feet long. Its eyes were larger than a man's head. The Plesiosaurus differed from the Ichthyosaurus in having a very small head, and a long neck like the body of a serpent. The Pterodactyle, or flying lizard, had a head like a crocodile, and wings like a bat.

(6). We have recognised *fire* and *water* as the two causes of the distribution of the earth's crust. Having an eye, like the Europeans, to mythological recollections, let us designate those formations which were due to water as Neptunic (*Várunika*), and those which were due to fire as Plutonic (*Ágneyika*). Considering the thinness of the earth's crust at these early periods, and the proximity of the internal fire, it seems that both earth and water must have possessed a higher temperature than at the present time; and that those beings only were produced upon the earth which were capable of existing under the then existing conditions. Thus we may understand how crocodiles anciently lived in the rivers of England, where (under the ice which now incrusts those rivers during the winter) they could not now exist. In like manner we may understand how palmtrees once flourished in England, where now they will not grow. That a deficiency of heat is the reason, is shown by this, that, in a large glass-house, in England, well-warmed artificially, palm-trees grow beautifully, and crocodiles, brought from India, flourish, as if in their native land.

(7). The chasms, before mentioned, in the crust of the earth, may have frequently been filled up by the contraction of the general mass, or by the influx of aqueous deposits. But in isolated localities where these chasms happened to be very wide, or from other causes, these openings have been preserved, and exist, up to the present day. To these openings we assign a name:—

*Aphorism IV.*

Openings in the earth, from which the water, penetrating to the ignited internal matter of the earth, causes eruptions of fiery matter, are called volcanoes.

(1). One of these is Barren Island, in the Bay of Bengal. Others are Vesuvius, Etna, Hecla, &c.

(2). When an eruption takes place, and red-hot melted matter is forced out from the mouth, or crater, of the volcano, this flows down the sides of the mountain, destroying everything it meets. Finally it hardens, forming the rock called lava.

(3). In course of time all volcanos seem to become extinct, as is the case already with many. That these extinct volcanos were formerly active, is inferred from their having craters, and their presenting masses of hardened lava, arranged just as we find it in the volcanos which are still active.

(4). It is by similar reasoning that we arrive at the conclusion that the unstratified rocks, which we have named Plutonic, were forced up in a state of fusion. The stratified rocks traversed by these, are hardened at the place of conjunction, as the inner side of the wall of a kiln is hardened by the fire. From similarity of effects, similarity of causes is inferred.

(5). We proceed to enumerate the unstratified rocks in their order.

*Aphorism V.*

Granite, Greenstone, Porphyry, and Basalt, are the Plutonic rocks.

(1). As Greenstone is found piercing through Granite, but never the reverse, the Granite must be the older formation. For the same reason Greenstone must be older than Porphyry, and Porphyry than Basalt. The newest igneous rock is the lava, which is formed during the eruptions of the volcanoes which are still active.

(2). The relative positions of the rocks, both stratified and unstratified can be conveniently illustrated by diagrams, which may be found in works specially devoted to the science of Geology.

*Aphorism VI.*

A knowledge of the relative position of rocks is of great importance to the miner.

(1). It must be understood that the stratified rocks do not occur everywhere in complete succession, as enumerated in Aph. II. What we assert is, that they never occur out of the regular succession. For example, clay-slate never occurs above coal, nor coal above chalk. Hence, where we find clay-slate at the surface, we know that it is needless to dig for coal;—and so of other cases. Fruitless labour and expense are thus saved.

(2). Having thus, in some measure, enquired into the constituents of the globe, and the causes of the arrangements of those constituents, we now proceed to enquire what aspect the globe consequently presents on its surface.

## SECTION II.—PHYSICAL GEOGRAPHY.

### *Aphorism VII.*

The ocean covers nearly three fourths of the surface of the globe. The great masses of land are found in the Northern portion of the globe, and the waters of the great ocean in the Southern portion..

(1). The great mass of land formed by Europe and Asia stretches from West to East over half the globe, while the American continent has its greatest length from North to South.

(2). It is observable that all the great masses of land terminate in a point, like a wedge, towards the South. This is seen, in a large scale, in the case of Africa and America, and, on a smaller scale, in India, Arabia, Malacca, Greece, Italy, &c.

(3). All the great continental masses of land rise gradually from the shores of the sea towards the interior. In all the continents the line of greatest elevation, instead of being central, is nearer to the coast on one side than on the other. Hence arise two unequal slopes towards the ocean in contrary directions. In the Old World (—meaning Europe Asia and Africa—) these declivities look North and South, whereas in the New World (—as America is called—) they look East and West.

(4) The principal slopes of the Old World are those which commence from the elevated land of central Asia. Northward of this, the ground slopes away, through Siberia, to the sea, for 2600 miles The southern slope reaches the sea at only 400 miles distance. In the New World the long and gentle slopes are toward the East, and the shorter and more precipitous towards the West.

(5), Another difference between the Old and the New World is to be found in the vast table-lands which abound in the former, while in the New World the level ground is comparatively little elevated above the sea. In central Asia there are vast table-lands of from 5000 to 14,000 feet in elevation, supported by huge chains of mountains.

(6). Upon the altitude and direction of the great mountain chains depend the course and extent of the great rivers.

### *Aphorism VIII.*

The tops of lofty mountains are cold, and there is a limit beyond which if a mountain rises it is always covered with snow from that limit to the top.

(1). Since the heat of the atmosphere constantly diminishes in ascending from the surface of the earth, there must in every country be a certain limit of elevation at which the air attains the temperature of freezing water. This limit, which is called the 'snow-line' or the 'limit of the snows' (*hima-símá*), differs in height, in different countries, according to the heat of the climate. In the Himálaya mountains (on the southern face) it is about 13,000 feet above the level of the sea. In the south of Europe, where the climate is colder than that of India, the line of perpetual snow is only about 9000 feet above the level of the sea; while, near the poles, snow covers the land down to the water's edge.

(2). A natural consequence of a river's taking its rise in a snowy range next requires our notice.

*Aphorism IX.*

Even when there is no fall of rain, those rivers which arise from the melting of the snow of lofty mountains become swollen in the hot weather.

(1). This is observable in the Ganges at Benares, and the reason of the increase of the water must be evident to those who reflect that the river comes from the melting of the snows of the Himálaya mountains.

(2). As the Ganges is flooded during the summer, so too is the river Nile in Egypt. The following remarks relative to the cause of the flooding of the Nile are taken from the work of the Grecian historian Herodotus, who lived 427 years before Vikramáditya (B C. 484).

(3). " Concerning the nature of this river," says Herodotus, " I was not " able to learn anything, from the priests or from any one besides, though " I questioned them very pressingly. For the Nile is flooded for a hundred " days, beginning with the summer solstice; and after this time it dimini- " shes, and is, during the whole winter, very small And on this head I " was not able to obtain anything satisfactory from any one of the Egyp- " tians, when I asked what is the power by which the Nile is in its nature " the reverse of other rivers. Yet there are Greeks who, wishing to appear " very wise, have offered three explanations of the peculiarities of this river. " Of these explanations one is as follows :—That the north-wind, which " blows in the summer, is the cause of the rise of the river by preventing it " from discharging itself into the sea. But often it has happened that the " north-wind has not blown ; yet the Nile has risen as high as ever. Be- " sides, if the north-wind were the cause, it would follow that all rivers " which flow against the north-wind must exhibit the same effect; and so " much the more as their streams are feebler. But there are many rivers " exposed to this wind which undergo no such change as that which takes " place in the Nile.

(4). " The second explanation is this that the rise of the Nile happens " because the Nile flows from the ocean, which, as they say, encompasses " the whole earth. But as to what is here said of the ocean, it is an obscure " fable, destitute of proof. I know of no such river as the Ocean. Homer, " perhaps, or some of the earlier poets, finding the name, transported it into " the language of poetry.

(5). " The third explanation is this, that the overflow of the Nile arises " from the melting of snows. But now, how can it be that a river which " rises in Libya, passes through Ethiopia, and discharges itself in Egypt— " thus proceeding from the hotter to the cooler regions,—should owe its rise " to snows? There are many reasons which may convince any man that " this cannot be the case. In the first place—and it is a sufficient evidence " to the contrary—the wind that blows from these regions is hot. Again, " the men of those countries are blackened with the heat. Besides, kites " and swallows remain there through the year, while cranes, flying from the " Scythian winter, take up their abode there during that season. But, of " necessity, none of these things would happen if, in the countries through " which the Nile runs, and where it takes its rise, snow fell even in the " smallest quantity."

(6). From all this it is clear that Herodotus was not aware of the difference between the climate of high mountains and of the plains in a torrid

region, which has been already declared. Those, on the other hand, who are acquainted with this fact in regard to mountains, would at once infer, from the overflow of the Nile in summer, that the river takes its rise in a snowy range, and that it does so, just as the Ganges does, has now been ascertained by inspection.

(7). Now, he who travels among the Himálaya mountains, and sees, one after another, innumerable peaks and innumerable streams descending from them, is apt to think that there is no order or arrangement in the matter :—but if he takes a comprehensive view of the whole at once, he will see that there is a certain amount of uniformity in the arrangement throughout, the nature of which we now proceed to declare.

*Aphorism XI.*

The Himálaya range of mountains extends East and West, along the North of India.

(1). In this range there are various roads by which travellers can pass the mountains into the countries beyond. The line of snowy mountains in which these passes occur is therefore called "The Ghát-line of the snows": —[the word *ghát* meaning a pass].

(2). Next, of the great peaks.

*Aphorism XII.*

From the Ghát-line of the Himálayas, the highest peaks, with their attendant ridges, extend southwards

(1). Beginning with the peak of Jamnautrí, where the Ganges rises, and reckoning eastward, these southward-pointing ridges are those of Jamnautrí, Nandadeví, Dhawalagiri, Goswámisthána (or Gosa'in-thán), Kanchangiri, Chamalárí, and the Gemini.

(1). Next as regards the distribution of the rivers belonging to these.

*Aphorism XIII.*

Between these ridges the numerous streams gradually unite to form a single river.

(1). Between the ridge belonging to the peak of Jamnautrí, which is 25,669 feet high, and Nandadeví, which is 25,598, the streams flowing down from the melting snow, gradually converge in consequence of the concave form of the region; and thus, although there are many considerable hills between these two ridges, such as the peak of Kedárnáth near Gangautrí, all the principal streams unite into one, and form the Ganges.

(2). In like manner, between the ridge belonging to the peak of Nandadeví and that belonging to the peak of Dhawalagiri, many streams unite to form the Karnátí, called also the Ghargaṭa (or Ghogra), and this falls into the Ganges.

(3). Again, between the ridge belonging to Dhawalagiri, and that of Goswámisthána, there are the rivers called collectively the Sapta-gandakí; and these, uniting into one stream which bears the name of the Gandaka, next join the Ganges.

(4). Between the ridge of the Goswámisthána and that of Kanchangiri, there are the rivers called collectively the Sapta-Kausika; and these unit-

ing next join the Ganges in one stream which bears the name of the Kausí. And so in the other valleys of like formation.

(5). Now, on leaving the mountain valley, what kind of ground do these rivers meet with before reaching the Ganges? On this point we have to remark as follows :—

*Aphorism XIV.*

These rivers cut their way through the range of sandstone hills that lies parallel to the Himálaya.

(1). This range of sandstone hills is not more than from 300 to 600 feet above the ground on either side.

*Aphorism XV.*

Above the sandstone range are the Dhúns, below is the Bhávar, and below that the Tará'í.

(1). The mean breadth of the Himálaya is about ninety miles. Let this be divided into three portions, of thirty miles each, and it will present three climatic divisions, the lower, middle, and upper. Let the lower region consist of the Tará'í, the Bhávar (or Sál forest), and the sandstone range with its Dhúns (or valleys),—i. e., let it occupy from the level of the plains to about 4000 feet above the sea.—the middle region will consist of the ground from there to about 10,000 feet above the sea; and the upper region, of the ground above that.

(2). Now, we mentioned before that the tops of high mountains are cold, and it is evident that if there be snow on the top of a mountain, and the air be warm at the foot, the temperature must be gradually colder from the foot to the top Now some animals love heat, and others love cold; and some plants love heat, and others love cold; and both animals and plants thrive best in those places where they find the temperature which they prefer. This is found to be the case all over the world; and how it is exemplified in the Himálaya we proceed to state:—

*Aphorism XVI*

Plants and animals are different at different heights on the Himálaya, as is the case with other high mountains also.

(1). Thus, as regards vegetation,—in the lower region there is the Sál (Shorea), the Síssú (Dalbergia), the Tund (Cedrela), the Palása (Butea), the Banian (Ficus Indica), the Peepul (Ficus religiosa), &c. In the middle region, instead of these, there are trees* that grow in such climates as that of England, and which will not thrive in warm climates. In the upper region there are pines, birches, and the congeners of such other plants† as love a degree of cold even greater than that of England.

(2). As regards zoology,—in the lower region live such animals;—men‡

* Oaks, Alders, Cherries, Pears, &c., correct names for which are not hastily to be determined in the plains.

† Junipers, larches, &c. ‡ The Koch, Bodo, Dhímal, &c.

&c,—as love heat. In the middle region live such* as suffer in the heat of the lower region. In the upper region live such† as cannot thrive in the heat even of the middle region.

(3). Then again, in the lower region there are elephants, rhinoceroses, tigers, and deer. In the middle region there are no elephants, rhinoceroses, or tigers, and only one kind of deer. In the upper region there are none of these, elephants, deer &c., while in that region alone, of the three, are found the wild goat and the wild sheep. Then again, there are in the upper region no crows such as are seen in the lower one, and very few of these are met with even in the central one.

(4). Thus, within the limits of the Himálaya, in consequence of the increasing coldness of the climate from the base upwards, there are to be found such climatic and other differences as are not usually to be met with except at wide intervals on the earth's surface.

(5). We shall now mention the great divisions of the earth's surface as recognised by Europeans.

*Aphorism XVII.*

The dry land is divided into four portions, called respectively Asia, Africa, Europe, and America.

(1). Now, how are these four to be recognised?

*Aphorism XVIII.*

Asia is the division in which India is situated, and Europe that in which is England:—Africa and Europe lie to the west of Asia, Europe being to the north of Africa:—America extends from north to south over great part of the hemisphere that is antipodal to India.

(1). Some countries are warm, and some are cold. With regard to the principal reason of this we have to observe as follows:—

*Aphorism XIX.*

The climate of a country depends mainly upon its receiving the sun's rays perpendicularly or obliquely.

(1). In countries near the equator, the sun's rays fall nearly perpendicularly upon the earth; and these countries are warm, as India. Countries placed nearer the pole receive the sun's rays obliquely, hence in smaller quantity, and are comparatively cold, as England.

(2). We have already explained how rivers take their rise in mountains, as the Ganges. e.g., in the Himálaya mountains. Now in Africa the mountains are few; hence the rivers are few, and much of that region is consequently a desert.

* The Lepchas, &c. † The Bhotiyas.

END OF BOOK SIXTH.

# A
# SYNOPSIS OF SCIENCE,
## BOOK VII.

## INTRODUCTION.

(1). Having, in some measure, described the Earth, which is in some parts suited for the habitation of Man, and in other parts not,—let us now enquire how men have distributed themselves over the earth, and what they have done there.

### Section I.—History.

(2). We proceed to give a concise account of what the European world in general regards as the true history of mankind.

*Aphorism I.*

The world was created by God. The first man and woman, by disobedience, forfeited God's favour, and thus sin and misery entered the world.

(1). 'The first man and woman', &c. They appear to have dwelt in Bactria, north of the Himálaya. From that spot mankind gradually spread over the earth.

(2). Now we narrate the commencement of the building of cities and villages by their descendants.

*Aphorism II.*

The first great city was Babylon, built by Nimrod, rather more than 2000 years before the time of Vikramáditya. Another great city, named Nineveh, was soon after built, not far from Babylon, by Asshur. This became the capital of the Assyrian monarchy.

(3). Next we have to notice the rise of a monarchy in Egypt.

*Aphorism III.*

The country watered by the river Nile, where the continent of Africa joins that of Asia, was the seat of a monarchy from very early times.

(1). Since the river Nile flows through that country, the ground there, though no rain falls, is fertile,—being overflowed by the river in its annual inundation. It was this that led to the founding of a kingdom there.

(2). Now we have to notice the history of Abraham.

*Aphorism IV.*

At an early period a wealthy and virtuous man, named Abraham, then resident in Babylonia, was called by God to leave his country, and to remove to Canaan, a country lying along the eastern shore of the Mediterranean sea which washes the north of Egypt.

(1). At the same time God promised that all mankind should be blessed through One who should be born among the descendants of Abraham.

(2). Now, in two aphorisms, we state briefly what befel the race of Abraham.

*Aphorism V.*

To Abraham, who accordingly removed to Canaan, was born Isaac; to Isaac Jacob, and from the twelve sons of Jacob arose the twelve tribes who are generally known under the name of Jews. In a season of famine, Jacob with his sons took refuge in Egypt.

(1).—Moreover—

*Aphorism VI.*

When the Jews became numerous, the Egyptians began to dread them, and attempted to stop their increase by putting all their male children to death. About 1450 years before Vikramáditya, the Jews, headed by Moses, abandoned the inhospitable country, and proceeded to resume the country of Canaan which God had given to their ancestor Abraham.

(1). Next we shall state, in three aphorisms, something regarding the history of Greece.

*Aphorism VII.*

On the northern shore of the Mediterranean, nearly opposite to Egypt, is the country called Greece. The whole of Greece is not larger than the Panjáb, yet it was divided into many separate states.

*Aphorism VIII.*

About 500 years before Vikramáditya, the Jews, who had been carried away captive by the Assyrians, were restored to their country by Cyrus the Persian, who put an end to the Assyrian empire. About half a century after this, Darius, then king of Persia, invaded Greece. He was utterly routed on the field of Marathon. The Persians, under his son (Xerxes), again invaded Greece, but without success.

*Aphorism IX.*

The victorions Greeks then resolved to retaliate by invading Persia. The invasion, under Alexander, took place about 300 years before Vikramáditya. Alexander, having overthrown the Persian empire, continued his march with the intention of conquering India.

(1). 'With the intention of conquering':—for he, having reached India, defeated Porus, the sovereign of the Panjáb; but he was then compelled to

retrace his steps, his soldiers refusing to accompany him further to the eastward.

(2). The historians of Alexander relate that a Bráhman, named Calanus, accompanied him on his return, who, finding the pains and weakness of old age approaching, prepared a funeral pile, and astonished the Greeks by consigning hmself to the flames.

(3). The name Calanus does not seem to be formed on the model of any Indian name; and it is probable that the Greeks, not understanding his language, and hearing him frequently employ the expression *kalyánam astu* ("may it be well with you!") as a benediction, made use of the sound *kalyána* as an arbitrary designation for him.

(4). Now, in three aphorisms, we state something regarding the history of the Romans.

*Aphorism X.*

To the westward of Greece there is a peninsula, streaching into the Mediterranean, very much in the form of a man's leg. The name of this peninsula is Italy. Its principal city, called Rome, was founded about 700 years before Vikramáditya.

*Aphorism XI.*

About the time of Vikramáditya the Romans had subdued almost all the countries of Europe. The leading man among them at that time was (Julius) Cæsar. Having subdued the country, now called France, which lies to the north-west of Italy, he found that a large island, called Britain, lay still further north. This island he invaded, and he subdued part of the southern portion now called England.

(1). Whatever learning the Britons at that time possessed was confined to a body of priests, called Druids, who held the doctrine of Transmigration and offered human sacrifices. It was not till more than six hundred years after Vikramáditya that the Christian religion began to prevail in Britain.

*Aphorism XII.*

About five hundred years after Vikramáditya, the great Roman Empire crumbled to pieces before the attacks of the inhabitants of the north of Europe, and out of the fragments the kingdoms of modern Europe arose.

(1). Now we state something regarding the history of Spain, one of these fragments of the Roman Empire.

*Aphorism XIII.*

One of these, the country called Spain, lies to the south of France. Somewhat more than 780 years after Vikramáditya, Spain was overrun by the Musalmáns, the followers of Muhammad.

(1). Here, since it is connected with the history of Spain, we mention something regarding the history of Muhammad, in the following aphorism.

*Aphorism XIV.*

Muhammad, about 680 years after Vikramáditya, established a new religion in Arabia.

(1). His followers, being excited by him to extend their religion by the sword, speedily subdued the countries on the African border of the Mediterranean.

*Aphorism XV.*

It was not till about 700 years after Vikramáditya that the complete expulsion of the Musalmáns from Spain was effected. They had attempted to extend their conquests to the north of Spain, but they received so severe a defeat that they did not again attempt to invade France.

(1). Now we have to mention something of America,—and first of its discovery.

*Aphorism XVI.*

About the time when the Musalmáns were expelled from Spain, Columbus proposed to various potentates the plan of a voyage of discovery across the ocean to the west of Europe.

(1). 'Proposed', &c:—for he argued that it was unlikely that the whole surface of the hemisphere opposite to that side of the globe where Europe and Asia are situated should consist of water alone. His views were at first ridiculed by many persons, some of whom said that it was impossible for men to live on the other side of the globe, because, if placed there, they must tumble off. Others, with the same notions, derisively asked him how his ships, if they once sailed down to the other side of the globe, could ever sail up again. Columbus replied to these objections by much the same arguments as those employed by Bháskara Áchárya. At length his arguments gained the assent of Queen Isabella of Spain, who furnished him with the means of making his voyage of discovery. He discovered the great continent of America.

(2). Now we have to mention something of the subsequent history of America.

*Aphorism XVII.*

Many Englishmen, having gone to America, settled there.

(1). When these settlers became numerous, they began to object to pay taxes to England, thinking that they were qualified to take care of themselves without the superintendence of the mother-country. This led to an unhappy war, which ended in England's leaving this colony to take care of itself, which it has hitherto done very well, having become a very populous and wealthy nation. It is presided over not by a king but by a president, a new one being elected every four years.

(2). Now in order to mark the date of the commencement of those events which have arisen out of the intercourse between England and India, we observe as follows.

*Aphorism XVIII.*

It was about 1650 years after Vikramáditya that the English began to establish those communications with India out of which the present condition of India has arisen.

(1). Now we must mention something of the recent history of France.

*Aphorism XIX.*

About 1850 years after Vikramáditya the French nation resolved that they would have no king. They put their king to death; but, after various attempts to carry on the government as a republic, the direction of affairs came into the hands of the leader of the army—named Napoleon Bonaparte. Having made himself emperor, Napoleon exerted all his power to destroy England; but in the end he was overthrown, and he died a captive.

(1). More recently the English and the French became allies in preventing Russia from invading Turkey. The barbarian government of Russia, like a strong robber, thinks itself justified in seizing, from its weaker neighbours, whatever it can seize. England and France, agreeing in condemning this robber-policy, united in defence of Turkey, and destroyed the great Russian fortress of Sebastopol. Russia was thus compelled, for the time, to abandon its designs on Turkey, and to accept terms of peace. As England and France are the type of the most advanced civilization, while Russia, availing herself of the discoveries of science only with the wicked view of more successful robbery, is the type of that barbarism which is the enemy of civilization and of human happiness, it were to be wished that the alliance between England and France should continue for ever. But the friendships of nations, not less so than those of individuals, are so liable to be broken by very trifling causes, that the permanence of the alliance is rather to be wished than hoped for.

(2). It will be seen, by the reader of history, that by one course of conduct a nation has become rich, while through another course it has become or remained poor. Beginning, then, a section on the causes of the increase and decrease of the wealth of nations, we first explain the meaning of the term Wealth.

## Section II.—Political Economy.

*Aphorism XX.*

Wealth is whatever can procure, by exchange, things desirable.

(1). Why do we say "by exchange?" Because many things which are desirable, but which are incapable of being exchanged, are not regarded as Wealth. For example—the air that we breathe, the light of the sun, &c. On the other hand, other articles,—such as fuel, cloth, salt, grain, &c. are capable either of gratifying our desires or of procuring for us other desirable objects in exchange.

*Aphorism XXI.*

(2). We indicate the foundation of the distinction.

What things, even though desirable, are attainable without difficulty, do not constitute Wealth.

(1). Thus exchange value implies intrinsic utility, and difficulty of attainment. For example, air for breathing is most desirable, but it is furnished to us without difficulty; hence it does not possess exchange value. A small piece of ice, from a lofty peak of the Himálaya, would be obtained with great difficulty, but it would possess no exchangeable value, from the absence of intrinsic utility. On the other hand, grain possesses exchange value, because it has intrinsic utility, and there is also difficulty, in the shape of the labour of the husbandman, &c., in procuring it.

(2). And you must not say, that diamonds and pearls, devoid of intrinsic utility, owe their great exchange value to the difficulty of tatainment only;—else we should have found great exchange value in the small piece of ice, devoid of intrinsic utility, but obtained with great difficulty from a peak of the Himálaya. The inutility of diamonds, pearls, &c., is asserted only by the foolish. Utility means the power of gratifying a desire. To diamonds and pearls, which are highly ornamental, this power belongs. Pearls are not dear merely because men must dive into the sea to procure them, but men dive into the sea to procure them, because, being much desired by kings and others, and being procurable only with difficulty, they fetch a high price.

(3). A drink of water, when water is very scarce, as on a march through the desert, bears a high price; and a prisoner, enclosed in a stifling dungeon, would willingly pay his gaoler for permission to inhale the pure air which usually costs nothing.

(4). Hence, too, fluctuation in the value of things desirable depends upon difficulty of attainment When grain is abundant, it is sold cheap; when it becomes scarce, its price rises.

(5). As there can be no exchanges, no buying or selling, without division of labour, we are next to consider the Division of Labour.

*Aphorism XXII.*

The division of labour greatly increases the wealth of nations.

(1). If a man previously accustomed to the conveniences of a civilized state of society were shipwrecked and cast shore upon an island hitherto unknown and uninhabited, he would find himself placed under the necessity, in order to exist, of devoting all his time and energies to the acquisition and manufacture of the various most simple necessaries of life: to erect some rudimentary habitation as a protection from the weather, to kill wild animals and dress their flesh, to plant vegetables, to make his own clothes, and supply other indispensable wants. The obvious consequence would be that he would be barely able to support a laborious and uncomfortable life, and that the variety of these unavoidable occupations would prevent his giving to any one of them that degree of time and attention by which alone he could expect to attain dexterity or perfection. But if, after some time spent in these solitary contrivances, a second person were accidentally brought to relieve his loneliness, the labours and anxieties of the two would be considerably lightened by their sharing between them the duty of providing for their united wants; for instance, while one was hunting, or otherwise occupied abroad, the other might be engaged in the several domestic arrangements necessary for their comfort. Their time

would thus be economized, because a hunter could provide food for two as easily as for one; the same fire which one must kindle for himself would accomodate both; and, in like manner, their other united wants would be supplied certainly with much less than twice the amount of time and trouble which either of them must have expended upon his own.

(2). To illustrate the question more fully,—suppose a number of travellers proceeding through some nearly desert country, and journeying together in a kind of cafila or caravan for the sake of mutual security: when they come to a halting-place for the night, they would not fail to make some kind of extemporaneous arrangement, that some should unlade and fodder the cattle, while others should fetch fire-wood from the nearest thicket, and others, water from the spring: some in the mean time would be occupied in pitching the tents, or erecting sheds of boughs; others in preparing food for the whole party; while some again, with their arms in readiness, would be posted as sentinels in suitable spots, to watch that the rest might not be surprised by bands of robbers. It would be evident to them that but for such an arrangement, each man would have to go both to the spring for water, and to the wood for fuel,—would have to prepare his own meal with almost as much trouble as it costs to dress food for the whole,—and would have to perform all these tasks encumbered with his arms, and on the watch against a hostile attack. Of course, if some of our supposed party chanced to be by nature or by practice peculiarly qualified for some particular task, and others for another, these would be respectively allotted to them in preference; but if there were no such inequality, the division would still take place, and the *chief* advantage of it would still be felt.

(3). Such a case as this exhibits an instance of what may be called a temporary Community, containing a distribution of labourers into several departments, which have a considerable correspondence with the different trades and occupations that are permanently established. One portion of the members of a community are employed to protect the rest from violence; another, to provide them with food; another, to construct their habitations; and so of the rest.

(4). As the various labourers in a state are all said to be engaged in producing, we must explain what is meant by production.

*Aphorism XXIII*

Production is the giving to any object its particular capacity to gratify human desires.

(1). The subject to which any value has thus been given, is called a Product.

(2). But how is the workman to support himself during the time required for the completion of a product? He must live on his own or on another's *capital*,—so we define Capital.

*Aphorism XXIV.*

The material, the instruments, and the workman's means of subsistence during production, constitute Capital.

(1). But if the labourer be supported by the capital of another, is all the product his own? Not so—

*Aphorism XXV.*

The proceeds of production are distributed into wages, profits, and rent.

(1). Wages are the price of Labour; Profits are the price of Capital, or the share in the product which goes to the Capitalist, Rent is the share which goes to the proprietor of the land, with its mines, water-power, &c., by which the raw materials of labour are originally furnished. A detailed explanation of this cannot be given here, for fear of prolixity.

(2). But what becomes of products? We reply.

*Aphorism XXVI.*

Things produced are either simply consumed, or are employed in producing more valuable products, or are exchanged for other productions.

(1). Thus a potter may exchange a number of pots which he cannot use himself, with a weaver, for a web of cloth, which he needs for clothing. This transaction is termed Barter.

(2). But sometimes the potter though wishing to exchange his pots for something desirable, may not wish to exchange them for a web; in this case the weaver if he desire the pots, may offer something which the potter may retain until he meet with a third person, who will give him what he wants, in exchange for this. Anything thus given in payment and intended not to be used but to be paid away again, serves the purpose of *money*. Thus, in some countries pieces of cloth, of a certain size, are current as money; in others, wedges of salt are used for the same purpose, in others, shells,—and so on. But the most convenient form of money is that of the precious metals.—

*Aphorism XXVII.*

The use of the precious metals as money greatly facilitates exchanges.

(1). Lycurgus, an ancient ruler of the Spartans, having taken an injudicious view of what was conducive to the happiness of his country, forbade the use of the precious metals as money, and allowed no metal to be coined except Iron. From the great weight of the iron money, and its small exchange value, it was quite unsuited for purposes of exchange. Exchanges consequently diminished, and the country became poor and savage. Other foolish laws in regard to money have injured the prosperity of nations. The most striking example, perhaps, of the effects of such an error, is afforded by a passage in the history of Spain. The large quantities of gold bullion which the Spaniards found and seized, upon their conquest of Peru, induced them to believe that they had become the possessors of inexhaustible wealth. Ignorant of the uses of wealth, and of the fact that gold is valuable only as a means of stimulating commerce, they passed a law forbidding its exportation, and so prevented its being used in the only way in which the command of it could possibly be an advantage. The consequence was, that while large masses of the precious metal, in bullion and plate, were accumulated in the possession of many private individuals, these same persons and the community at large were suffering a want of the most common necessaries of life. On this occasion, the government of Spain were guilty of conduct which, on the part of a single individual,

would be justly commiserated as insanity. If an individual possessing a large sum of money in gold coins were to deny himself food, warmth, and shelter, until his sufferings terminated his existence, there would be no hesitation in pronouncing that he had destroyed himself, under the influence of chronic insanity; and the fact that such a course has been pursued by a whole nation cannot possibly make it appear more rational.

(2). Thus we have seen how certain arrangements increase the wealth of a nation, and how an unwise interference with the natural course of these arrangements may impoverish a nation. It is obvious that the wealth of a nation consists of that of the individuals who constitute the nation. But do arrangements which enrich the nation always benefit each individual? Nay.—

### *Aphorism XXVIII.*

The excessive subdivision of labour tends to injure the character of the labourer.

(1). One evil result of the division of labour when carried to a great extent, is the reducing each man too much to the condition of a mere machine, or rather one part of a machine; the result of which is, that the mind is apt to be narrowed—the intellectual faculties undeveloped, or imperfectly and partially developed, through the too great concentration of the attention on the performance of a single, and sometimes very simple, operation,—such as the pointing of a pin.

(2). But is it right that the well-being of individuals should be thus sacrificed to the increase of wealth of the nation? The question is an important one,—but it does not belong to Political Economy, which is concerned about the increase and decrease of national wealth, not about Right and Wrong,—to treat of which we begin a new Section.

## Section III.—Ethics and Law.

(3). Now, as the topic suggests it, we shall consider whether the objects of knowledge may not be divided and classified in various ways. We know that they are diversely classified in the Sánkhya Philosophy and in the Nyáya. Aristotle made the division according to the three questions (1) What *is*, and might have been otherwise?—(2) What is, and *must* needs have been so?—and (3) What *ought* to be? Whatever is ascertained in reply to the first question, may be ranked under the head of *Physics;* whatever is ascertained in reply to the second, under *Metaphysics*; and whatever in reply to the third, under *Ethics*. For example, a piece of clay, known previously to have been soft, is found to have become hardened into a piece of brick. We cannot conceive that this change took place without some cause. That there *must* be a cause of everything that begins to be, is reckoned a Metaphysical fact, i.e., a fact independent of any particular established order of Nature. On enquiry as to the cause in the case of of the hardened clay, we learn that the clay had been brought into contact with fire. That the fire hardens clay is a fact which we have no difficulty in conceiving to be otherwise; we could conceive the fire to soften the clay, as it actually does soften wax. That fire hardens clay, ard softens wax, is a Physical fact, i.e. one included under the existing order of Nature. The question never occurs to us whether it be *right* or *wrong* in the fire

that it hardens clay or softens wax: we neither commend the fire in the one case, nor blame it in the other. The question of right and wrong, however, does present itself when we observe the actions of mankind. Some actions excite our disapproval, while others extort our approval. We call the one set wrong, the other right. We say that the one kind of actions *ought not* to be done, and that the others *ought* to be done. "The word *Ought* introduces the mind into a new region, to which nothing physical corresponds."* This is the region of *Ethics*, or *Morality*.

(4). We have remarked that ethical considerations do not apply to such things as fire,—whether it harden a thing, or soften a thing, or whatever else it may do; but that these considerations apply to human beings. Do they, then, also apply to *brutes*,—who perform actions which we reward by caresses, or punish by blows, in order to encourage or to check their repetition? No. The difference between the two cases is this, that the brute, when it does what we see proper to check, *does not know that it is doing wrong*, nor can it be made to know this. It can only be made to know that if it do certain acts, punishment will follow. Man, on the other hand, can be made to recognise an act as right or wrong without reference to the consideration of immediate reward or punishment. Man alone, therefore, of the inhabitants of the earth, is regarded as a Moral Agent. In other words, man's actions may have a moral quality. We proceed to consider what is meant by the *moral quality* of an action.

*Aphorism XXIX.*

By the *moral quality* of an action, we mean its being *right* or *wrong*.

(1). But how do we know that an action is right or wrong?

*Aphorism XXX.*

The faculty by which we recognise a distinction in the moral quality of actions, is called *conscience*.

(1). Conscience manifests itself in a judgment of the mind respecting duty, accompanied by an emotion of approval or of disapproval.

(2). But why are we bound to defer to the dictates of Conscience?

*Aphorism XXXI.*

The supremacy of Conscience is involved in the very conception which men form of this faculty.

(1). Conscience, by disapproving, may forbid the will to contribute to the gratification of a desire. No desire ever forbids the will to obey the conscience. However often we disobey the voice of this monitor, we always have the feeling of self condemnation accompanying our disobedience. To the same effect Manu speaks, in his 8th Chapter, with advertence to the magistrate's warning the witnesses to speak the truth:—"The soul itself is its own witness; so is the soul its own refuge; offend not thine own soul, the best witness of men—[inasmuch as its testimony may support them under false accusations, whereas the applause of the world is of no avail to him whose Conscience condemns him]."

* Macintosh's Dissertation.

(2). But is this guide to be trusted,—seeing that the conscience of one man, e. g., a Thug, approves and enjoins what the conscience of another man condemns? In regard to this we state.

*Aphorism XXXII.*

Conscience may be more or less perfectly enlightened.

(1). As Conscience involves a judgment of the mind respecting duty,—and as no man's knowledge is perfect or infallible,—it follows that so far as there is error in the judgment, in relation to matters of duty, just so far the conscience is liable to be misguided.

(2). But is a man blameable who, in obedience to his conscience, does what is wrong? Yes,—because that ignorance which might have been avoided, never excuses from blame. When we do wrong while obeying the dictates of conscience, the error does not consist in that obedience, but in not following the right rule, with which rule the accountable moral agent should be acquainted.

(3). But how is conscience to be enlightened?

*Aphorism XXXIII.*

Conscience must be enlightened either by the exercise of reason, or by revelation.

(1). The exercise of reason, in discerning the coincidence between the useful and the morally right, helps to enlighten the Conscience; for,—

*Aphorism XXXIV.*

Of no action which is morally right is the ultimate result injurious, nor of any action which is morally wrong is the ultimate result beneficial.

(1). How revelation may enlighten the Conscience, is evident.

(2). Well, what are the actions enjoined and forbidden by an enlightened Conscience? With a view to answering this question, we divide Duties.

*Aphorism XXXV.*

One's duties are either towards God, or one's neighbour, or one's self.

(1). One's duties towards God are fear and love, implying a willing obedience to His revealed will. One's duties towards one's neighbour are either determined by law, e. g., not to steal, or not so determined, e g., benevolence. One's duties towards one's self are Self-preservation, Temperance, and Purity.

(2). One's duties towards one's neighbour being expressly determined by Law, or not so determined, proceeding now to say something regarding Law, we give Bacon's division of its aims.

*Aphorism XXXVI.*

"The use of the law consisteth principally in these three things, (1) to secure men's persons from death and violence, (2) to dispose the property of their goods and lands, and (3) for preservation of their good names from shame and infamy."

(1). All good laws consist in more particular applications of certain very general principles, of which, as embodied in the current maxims of the law, we shall now notice one or two.

*Aphorism XXXVII.*

*Salus populi suprema lex* (—i. e., That regard be had to the public welfare, is the highest law).

(1). In cases of necessity, the welfare of the individual must yield to that of the community. When a city is on fire, the house of an individual may be pulled down, to arrest the progress of the fire.

*Aphorism XXXVIII.*

*Leges posteriores priores contrarias abrogant* (—i. e. When the provisions of a later statute are opposed to those of an earlier, the earlier statute is considered as repealed.)

*Aphorism XXXIX.*

*Nova constitutio futuris formam imponere debet non præteritis.* (—i, e., A legislative enactment ought to be prospective, and not retrospective, in its operation.)

(1). The injustice or impolicy of retrospective legislation is more apparent with reference to criminal laws, than to such as regard property or contracts. It would be unreasonable, after an action is committed, then for the first time to declare it to have been a crime, and to inflict a punishment upon the person who has committed it, because it was impossible that the party could foresee that an action innocent when it was done, would be afterwards converted into guilt by a subsequent law; he had therefore no cause to abstain from it, and all punishment for not abstaining must, of consequence, be cruel and unjust.

(2). It is sometimes necessary, however, to make laws applicable to past transactions in regard to property.

*Aphorism XL.*

*Nemo debet esse judex in propria sua causa.* (—i. e., No man can be a judge in his own cause).

(1). Where a judge is interested in the result of a cause, he cannot, either personally or by deputy, sit in judgment upon it.

*Aphorism XLI.*

*Non potest adduci exceptio ejusdem rei cujus petitur dissolutio:* (—i. e., A matter, the validity of which is at issue in legal proceedings, cannot be set up as a bar thereto).

(1). Thus if a party appeal against an attainder, the fact of his having been attainted cannot be set up as a bar to his being heard on that point.

*Aphorism XLII.*

*Allegans contraria non est audiendus* (—i. e., He is not to be listened to who alleges things contrary to each other).

(1). Thus if a man, in order to escape responsibility, denies that he is a trustee in a certain case, he cannot be allowed afterwards to claim the emoluments attached to the office on the plea of his being a trustee.

*Aphorism XLIII.*

*Sic utere tuo ut alienum non laedas*. (—i. e., Enjoy your own property in such a manner as not to injure that of another person).

(1). Thus a man is at liberty to build a house on his own ground, but he must not build it in such a way that the rain-water pouring from the roof shall damage the house of a neighbour.

(2). So much for laws whose sanctions are punishments inflicted by human judges.

(3). Now of duties towards one's neighbour which are not enforced by legal penalties, but the fulfilment or the infraction of which is regarded with approval or disapproval by God, the Supreme Judge.

*Aphorism XLIV.*

One's duties towards one's neighbour, enjoined by God, though their infraction is not punished by human laws, are Benevolence, Gratitude for favours received, &c.

(1). Here it is assumed that there is a God, but this is denied by the Sánkhya, who contends that there is no evidence of a God. We therefore commence a section on the evidence that there is a God.

SECTION IV.—NATURAL THEOLOGY.

(2). In the *Siddhánta Muktávalí* we find the following argument:—"Such productions as a water jar are produced by a maker, and so also are "the earth and the trees; and to make these is not possible for such as we "are; hence the existence of the Deity, as the Maker of these, is established." The principle on which this argument is based is the following.

*Aphorism XLV.*

The evidence of design proves a designer.

(1). 'The evidence of design,' i. e. some purpose manifestly accomplished. "The question which the theologian always puts upon each discovery of a "purpose manifestly accomplished is this.—'Suppose I had this operation to "perform by mechanical means, and were acquainted with the laws regu-"lating the action of matter, should I attempt it in any other way than I see "here practised?' If the answer is in the negative, the consequence is irre-"sistible that some power, capable of acting with design, and possessing the "supposed knowledge, employed the means which we see used."*

* Lord Brougham,—Discourse, p. 32.

(2). But may not Nature, as described in the 57th of the *Sánkhya Kárikás*, operate spontaneously and unconsciously, as the milk spontaneously and unconsciously becomes developed in the udder for the sake of the calf? We reply.—

*Aphorism XLVI.*

The *Sánkhya* instance is not a fact, for the milk does *not* spontaneously become developed in the udder.

(1). Let a story be heard in illustration of this point. A certain king's son, observing that at the times when he periodically became hungry, a variety of food arrived at the door of his apartment, and was then presented to him by his immediate attendants, came to the conclusion that "Cooked food developes itself spontaneously for my sake". On his expressing this opinion, he was informed as follows:—"The cooked food is the result of a series of suitable processes which take place in consequence of the instigating will of your father the king." In like manner the powers of Nature work to our benefit, not spontaneously, but as directed by the will of our Heavenly father.

(2). Has, then, the God of Nature anywhere directly revealed His will to man? The answer to this question must be sought for by the candid enquirer, conversant with the laws of evidence and with the facts of Nature, in an examination of those Institutes which claim to be revelations of God's will. So we advise—

*Aphorism XLVII.*

Let professing revelations be examined.

(1). But if these professing revelations be numerous, with which shall we begin? Let the enquirer receive this our advice at parting. If a pretending revelation encourage the worshipping of idols, besides many cruel vicious and frivolous practices, it is not likely to have come from God. Again, if the professing revelation allure its votaries by promising sensual enjoyments hereafter to the slayers of those who see no reason to believe in it, then this also is not likely to have come from God But if there be a professing revelation which inculcates personal purity, love to God, and active goodwill towards our fellow-men, then such a professing revelation as this would seem to deserve that the evidence in support of its professions should be carefully examined by the intelligent who seek for the Chief End of Man. May the enquiry be blessed.

THE END.

## ॥ भूमिका ॥

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सुनिपुणानां बुद्धिमतां विचारे परस्परविरोधः केवलं दुःख-हेतुः। वादिप्रतिवाद्यभिमतार्थस्याभेदेऽपि यदि तयोर्भाषाभे-दमात्रेण भेदावभासः तर्हि सोऽपि तथैव। अन्योन्यमततत्त्वप-रीक्षणात्पूर्वं परस्परनिन्दादिकं निष्फलत्वादनुचितं। अपिच यत्र केवलं विवदमानयोर्द्वयोरपि भ्रान्तिमूलकविवाददूरीकरणार्थः प्रयत्नो महाफलत्वात्प्रशस्यस्तत्र भूखण्डद्वयनिवासियावद्व्यक्तीनां परस्परं विवाददूरीकरणार्थकप्रयत्नः प्रशंसायोग्य इति किं वक्तव्यम्। एतादृशप्रयत्नकारी पुरुषः सम्पूर्णफलाप्राप्तावपि न निन्द्यः। भारतवर्षीयार्यजनानां प्राचीनस्वमतग्रन्थपरिपालनं तत्प्रेमच तेषां महास्तुतिकारणम्। एवं प्रतिदिनं वर्द्धमानस्व-मतग्रन्थाभ्याससजनितसततज्ञानवृद्ध्या सन्तुष्यन्तो यूरोपीयलोका अपि न निन्द्याः। यदि कश्चिद् युरोपीयजनो भारतवर्षीया-र्योक्तं वास्तवमपि तदीयव्यवहारं तन्मततत्त्वंच यथार्थतोऽवि-ज्ञाय निन्देत्तदनुचितमेव। एवं यदि भारतीयजनो युरोपीयम-तमविज्ञाय निन्देत्तदपि तथैव। एवञ्चान्यतरभ्रान्तिजनितमत-

विरोधप्रयुक्तदुःखस्य हेयतया तद्दूरीकरणायावश्यं कश्चिदुपायो चितमतस्वीकारे सति सत्फलासम्भवोऽनीप्सितदुष्टफलसम्भवश्च । अतो विचारिणोर्द्वयोरेकविषये मतभेदे सदसन्निर्णयाय वादः समुचितः । परन्तु यावत्सम्यक्प्रकारेण मतभेदो नावधृतस्तावद्वादोऽपि न समीचीनः । प्रथमतो मतयोर्यथासम्भवं साम्यं निर्णीय तदुत्तरं भेदनिर्णयः कर्तव्यः येन मतैक्ये विवादो न भवेत् ॥

तदेवं पूर्वोक्तहेतुना भारतीयानां युरोपीयानां मतयोस्साम्यवैलक्षण्यनिर्णयेच्छायां जातायां यस्मिन् ग्रन्थविशेषे भारतीयमतं सम्यक् साकल्येन स्पष्टीकृतं तद्ग्रन्थान्वेषणं प्राप्तं । तत्र च तर्कशास्त्रीयग्रन्थानवलम्ब्य मतैक्यवैलक्षण्ये परीक्षणीये यतस्तेषु निखिलदर्शनस्थविषयाः संक्षेपेण बहवश्च तच्छास्त्रीयविषया विस्तरेणोपलभ्यन्ते । भारतवर्षे बहूनां दर्शनानामुपलम्भेऽपि केवलं तर्कशास्त्रमात्रेण सह युरोपीयमतस्य साम्यवैलक्षण्ये निरूपणीये नत्वन्यैरपि तर्कशास्त्रज्ञानस्य सकलशास्त्रज्ञानमूलत्वात् । यथा प्रयागगयाकाशीसंज्ञकस्य नगरत्रयस्य परस्परविप्रकर्षं तदवस्थितिदिग्भागांश्च यो वस्तुतो जानाति स चेदुज्जयिन्यादेर्नगरान्तरस्य तच्चितयमध्ये एकेन केनचित्सह विप्रकर्षं दिशञ्च जानीयादपराभ्यामपि ताभ्यां तद्विषये निर्णयवान् स्यात् स्पष्टत्वात् । तथा यदि सम्यक्परिचितसर्वदर्शनः पुरुषस्तर्कशास्त्रेण सह यु-

दिशास्त्रैः सह तस्य साम्यवैलक्षण्यविषये गतसन्देहः स्यात्। तदेवं पूर्वोक्तविषयनिरूपणाय प्रारीप्सितस्य ग्रन्थस्याधिकारी स एव यो गौतमसूत्रप्रथमाध्यायार्थवेत्ताऽमत्सरश्च यतः प्रथमाध्याये गौतमेन सकलं न्यायमतं संक्षेपेण सूत्रितम्। मतयोर्वैलक्षण्ये परीक्षणीये प्रथमतो विस्तरेणैक्यनिर्णयो यथासम्भवं कर्तव्यः यतस्तत्रोपन्यस्तानां बहूनामुदाहरणानां वैलक्षण्यनिर्णये महानुपयोगो भविष्यति। अत्रातयुरोपीयमतसम्बन्धिविषयाणां अतिस्पष्टरूपेण प्रकाशनार्थञ्चैतद्ग्रन्थनिर्माणमहाप्रयत्नः। तथाकृतेऽपि यदि श्रोतृणां कस्मिंश्चिद्दृष्टाश्रुतपदार्थे सन्देहःस्यात् तर्हि तत्पदार्थनिरूपणनिपुणाद्युरोपीयजनान्निर्णयः प्राप्तव्यो न तु ग्रन्थ एव हेयतया ज्ञातव्यो ऽज्ञाततत्त्वे विषये बोधकापेक्षायाः सार्वत्रिकत्वात्। यः पुनर्विषयो यन्त्रादिद्वारकदर्शनादेव निर्णेतुं तत्त्वतः शक्यस्तस्य निर्णयस्तेनैव कर्तव्यो न तु तद्ग्रन्थवाक्यमात्रेण। यदि चाधीतात्मज्ञानशास्त्रः प्रेक्षावानेतद्ग्रन्थानेकप्रकरणेषूपन्यस्तानां भौतिकपदार्थानां निरूपणं न रुच्या प्राधान्येन द्रक्ष्यति तर्हि अनुमानीयदृष्टान्तसिद्ध्यर्थमेव तत्सर्वं जानातु। यदि पुनरात्मतत्त्वज्ञो विविधयन्त्ररज्जुप्रभृतीन् तत्तद्व्यापारांश्चात्र ग्रन्थे निरूपितानतितुच्छान्मन्येत तर्हि यथैव पूर्वेषां ज्योतिःशास्त्राचार्याणां न्यायाचार्याणां वा ग्रन्थेषु दृष्टान् नक्षत्रदंशसत्राटीन दण्डचक्रचीवरकुलालकपालप्रभृतींश्च जि-

रोपीयमतस्य सम्मतिविमती जानाति तर्हि अन्यैरपि वेदान्ता-म्मासुजनबोधनार्थान् दृष्टान्तान्मन्यते तथैवैतानपि स्वीकरोतु तत्तत्पदार्थस्वरूपपरिचये सति तदीयबहुविधापूर्वधर्मज्ञानरूपस्य महाफलस्य सम्भवात् ॥

। १ । दुर्ज्ञेयानन्तगुणैर्वस्तुभिरापूरितं जगदनन्तैः । यः सृजतीच्छामात्रात् स सदा परमेश्वरो जयति ॥ १ ॥ तस्यैव कृपावशतो विचार्य चिरमक्षपादसूत्रार्थम् । रचयाम्यभिनवरीत्या निबन्धमेतं जनोपकाराय ॥ २ ॥ यन्नूत्नमिङ्गलण्डीयानां मतं यन्नौतमस्य च । तयोः साम्यं विरोधश्च विषयोऽत्र विविच्यते ॥ ३ ॥ बहुलप्रयत्नरचिता बह्वर्थाऽल्पाक्षराऽप्यसन्दिग्धा । बालशर्मणस्य कृतिर्भूयादेषा मुदे विदुषाम् ॥ ४ ॥

। २ । इह खल्वात्मादेः प्रमेयस्य तत्त्वज्ञानं परमपुरुषार्थोपकारीति सर्वे भारतवर्षीयास्तदन्यवर्षीयाश्चानुमन्यन्ते शास्त्रकृतः । अतः परमपुरुषार्थार्थिभिरवश्यमात्मानात्मपदार्थानां तत्त्वज्ञानस्य प्राप्तौ यतितव्यम् । एवं येन किमपि तद्विषयतत्त्वज्ञानं प्राप्तं तेन तदुपदेशेऽपि यतितव्यम् । अतस्तेषां पदार्थानां विचारमारभमाणो विचारविषयानुद्दिशति प्रमाणेत्यादिना ॥

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प्रमाणप्रमेयसंशयप्रयोजनदृष्टान्तसिद्धान्तावयवतर्कनिर्णयवादजल्पवितण्डाहेत्वाभासच्छलजातिनिग्रहस्थानानां तत्त्वं विचार्यते तत्त्वज्ञानाय । तस्य परमपुरुषार्थोपकारित्वात् ॥ १ ॥

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। १ । तस्येति । तत्त्वज्ञानस्येत्यर्थः ॥

। २। अत्र च सर्वफलप्राप्तेः करणाधीनतया तत्त्वज्ञानप्राप्तावपि तत्करणमपेक्ष्यत इत्यभ्यर्हितत्वात् प्रमाणानां प्रथममुपन्यासः ॥

। ३। तत्र तत्त्वज्ञानं येन क्रमेण परमपुरुषार्थोपकारि तत्क्रमप्रतिपादनाय सूत्रम् ॥

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दुःखङ्कुप्रवृत्तिरनुचितरागादिर्मिथ्याज्ञानञ्चैतेषामु-
त्तरोत्तरापायमन्तरा न तज्जन्यपूर्वपूर्वापायो न च
तमन्तरा परमः पुरुषार्थः ॥ २ ॥

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।१। अत्र दुःखजन्मप्रवृत्तिदोषमिथ्याज्ञानानामुत्तरोत्तरापाये तदनन्तरापायादपवर्ग इति गौतमसूत्रम् । तत्र मिथ्याज्ञानापगमे रागद्वेषमोहाख्यास्त्रयो दोषा अपयान्ति । ततः प्रवृत्तिर्न भवति । तेन जन्म न जायते । ततश्च दुःखं न भवति । दुःखात्यन्तनिवृत्तिरेव च परमः पुरुषार्थ इति गौतममतम् । अस्मन्मतन्तु अनुचितरागादिकं तावत्केवलमिथ्याज्ञानजन्यमस्तीति न इदं परस्य धनं मया न ग्राह्यं ग्रहणे च मम दोषो भविष्यतीत्यादेर्धर्मतत्त्वज्ञानस्य मिथ्याज्ञानविरोधिनः सत्त्वेऽपि परधनाद्यंशे पुरुषाणां रागसत्त्वात् । अतश्च मिथ्याज्ञानापायेऽनुचितरागापाय इति न सम्भवति परन्तु मिथ्याज्ञानजन्यं यद्यदनुचितरागादिकं तस्य मिथ्याज्ञानापायमन्तराऽपायो न भवति । तं विना च न परमः पुरुषार्थ इति ॥

❋ । २ । समाप्तं प्रयोजनप्रकरणम् ॥ ❋

। ३ । अथ यथोद्देशं लक्षणस्यापेक्षितत्वात् प्रथमोद्दिष्टं प्रमाणं लक्षयति विभजते च ॥

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यथार्थज्ञानं प्रमा तस्याः करणं प्रमाणं तच्च द्वेधा प्रत्यक्षमनुमानञ्चेति ॥ ३ ॥

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। १ । अत्र प्रत्यक्षानुमानोपमानशब्दाः प्रमाणानीति गौतमसूत्रम् । तत्र प्रत्यक्षानुमानयोरिवोपमानशब्दयोरपि स्वातन्त्र्येण प्रामाण्यमिति गौतममतम् । अस्मन्मतन्तु गोसदृशो गवयपदवाच्य इति वाक्यार्थज्ञानोत्तरस्य गवये गोसादृश्यज्ञानस्योपमानत्वेनाभिमतस्य वाच्यवाचकभावानुमितिजनकत्वमेव । शब्दस्य च देवदत्तो ग्रामं गच्छतीत्यादिवाक्यरूपस्य देवदत्तकर्तृकग्रामगमनविषयकवक्तृज्ञानानुमापकत्वमेवेति न तयोः स्वातन्त्र्येण प्रमाणतेति तात्पर्येण तच्च द्वेधेत्युक्तम् ॥

। २ । अथोक्तं प्रमाणद्वयं यथाक्रमं लक्षयितुमारभते तत्र प्रथमं प्रत्यक्षं लक्षयति ॥

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प्रत्यक्षं नाम तत्र तत्र शरीरावयवे वर्तमानः शक्तिविशेषो यद्बलात् सति तस्य तस्य शरीरावयवस्य स्वार्थसम्बन्धे तदर्थस्य साक्षात्कार उत्पद्यते ॥ ४ ॥

। १ । अत्रेन्द्रियार्थसन्निकर्षोत्पन्नज्ञानकरणं प्रत्यक्षमिति गौतममते प्रत्यक्षलक्षणं तत्स्वात्माश्रयदोषात् परित्यक्तं तथाहि प्रत्यक्षशब्दस्येन्द्रियशब्दपर्यायतया कुठारोत्पन्नच्छेदकरणं कुठार इत्यादिलक्षणवत् तस्यानुपपत्तेः । एवं यद्यपि प्रत्यक्षशब्दस्य विषयो ज्ञानं ज्ञानकरणमिन्द्रियं चेति त्रयोऽर्थास्तथापीह प्रत्यक्षपदमिन्द्रियेष्वेव शक्तिविशेषेषु प्रयुज्यतेऽतो नात्रान्यार्थोपस्थितिमूलकभ्रमसंदेहयोरवकाश इति ॥

। २ । अथानुमानं लक्षयति विभजते च ॥

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अथ तत्पूर्वकं त्रिविधमनुमानं पूर्ववच्छेषवत्सामान्यतो दृष्टञ्च ॥ ५ ॥

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। १ । तत्पूर्वकं प्रत्यक्षपूर्वकं त्रिप्रकारकमनुमानमित्यर्थः । तस्य त्रैविध्यं दर्शयितुमाह पूर्ववदित्यादि । यत्र कारणेन कार्य्यमनुमीयते तत् पूर्ववत् । यथा मेघोन्नत्या भविष्यति वृष्टिरिति । यत्र पुनः कार्य्येण कारणमनुमीयते तत् शेषवत् । यथा पूर्वोदकविपरीतमुदकं नद्याः पूर्णत्वं शीघ्रत्वञ्च स्रोतसो दृष्ट्वाऽनुमीयते भूता वृष्टिरिति यत्रैकत्र पुष्पिताम्रदर्शनादन्यत्रापि पुष्पिता आम्रा इत्यनुमीयते तत् सामान्यतोदृष्टमिति ॥

। २ । अथ शब्दोपमानयोः स्वातन्त्र्येण प्रामाण्याभावेऽप्यनुमानविधया प्रामाण्यस्य स्वीकारात् गौतमोक्तस्य तल्लक्षणवि-

भागादेः स्वानुमतत्वाच्च शिष्यबोधनार्थमुपमानशब्दौ दर्शयिष्यन्नादावुपमानं लक्षयति ॥

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प्रसिद्धसाधर्म्यात्साध्यसाधनमुपमानम् ॥ ६ ॥

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। १ । प्रसिद्धस्य पूर्वं ज्ञातस्य साधर्म्यात् सादृश्यज्ञानात् साध्यस्य साधनं सिद्धिर्यतस्तदुपमानमित्यर्थः । यथा अयं गोसदृश इति ॥

। २ । शब्दं लक्षयति ॥

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आप्तोपदेशः शब्दः ॥ ७ ॥

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। १ । स्पष्टम् ॥ तं विभजते ॥

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स द्विविधो दृष्टादृष्टार्थत्वात् ॥ ८ ॥

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। १ । स शब्दो द्विप्रकारक इत्यर्थः । यस्येह दृश्यतेऽर्थः स दृष्टार्थः । यथा गङ्गादिशब्दः । यस्य चामुत्र प्रतीयतेऽर्थः सोऽदृष्टार्थः । यथा स्वर्गादिशब्द इति ॥

॥ ❋ ॥ २ । समाप्तं प्रमाणप्रकरणम् ॥ ❋ ॥

। ३ । अथानेन द्विविधेन प्रमाणेन किं वेद्यमित्याकाङ्क्षायां प्रमेयप्रकरणमारभमाणः प्रमेयं विभजते ॥

आत्मा शरीरमिन्द्रियाण्यर्था बुद्धिर्मनः क्लुप्रवृ-
त्तिरनुचितरागादिः सांसारिकजीवनं फलं दुःखं
परमपुरुषार्थश्चेति द्वादशविधं प्रमेयम् ॥ ९ ॥

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।१। स्पष्टम् ॥ तत्र प्रथमोद्दिष्टमात्मानं लक्षयति ॥

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इच्छाद्वेषप्रयत्नसुखदुःखज्ञानान्यात्मनो लिङ्गम् ॥ १० ॥

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।१। लिङ्गं लक्षणमित्यर्थः ॥

।२। क्रमप्राप्तं शरीरं लक्षयति ॥

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चेष्टेन्द्रियार्थाश्रयः शरीरम् ॥ ११ ॥

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।१। चेष्टाच प्रयत्नजन्यो व्यापारविशेषः । चक्षुरादीनीन्द्रियाणि । अर्थः सुखदुःखे । एतेषामाश्रयः शरीरमित्यर्थः । अत्र चेष्टाश्रयत्वादि प्रत्येकं लक्षणम् ॥

।२। क्रमप्राप्तमिन्द्रियं विभजते लक्षयतिच ॥

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घ्राणरसनचक्षुस्त्वक्श्रोत्राणीन्द्रियाणि भूतगुणानां
तज्जन्यद्रव्यगुणानां च ग्राहकाणि ॥ १२ ॥

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।१। अत्र घ्राणं गन्धस्य रसनं रसस्य चक्षुरिन्द्रियं रूपस्य त्वक्

स्पर्शस्य श्रोत्रं शब्दस्य ग्राहकमतस्तत्तद्गुणग्राहकत्वमिन्द्रियाणां लक्षणमिति भावः ॥

। २ । भूतान्येव कानीत्याकाङ्क्षायामाह ॥

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भूतान्युपषष्टिसंख्यानि ॥ १३ ॥

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। १ । अत्र पृथिव्यापस्तेजो वायुराकाशमिति भूतानीति गौतमसूत्रम् । अस्माभिस्त्वेषां पृथिव्यादीनां भूतत्वं न स्वीक्रियते । यतो भूतत्वं नामामिश्रद्रव्यत्वम् । तच्च परस्परविजातीयानेकावयवसंयोगाजन्यद्रव्यत्वं । न च पृथ्वीजलवाय्वादेस्तथात्वमस्ति । तदारम्भकावयवानां परस्परविजातीयत्वस्य सुदृढाभिरनेकविधाभिः परीक्षाभिः सिद्धत्वात् । किन्तु वक्ष्यमाणानां प्राणप्रदादीनामेव भूतत्वं सम्भाव्यते । तदारम्भकावयवानां परस्परविजातीयत्वस्याद्यावधि कयापि परीक्षया सिद्धत्वाभावात् । एतद्विषयोपपत्तिविस्तरस्तु रसायनप्रकरणे द्रष्टव्यः ॥

। २ । क्रमप्राप्तमर्थं विभजते लक्षयतिच ॥

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गन्धरसरूपस्पर्शशब्दा भूतानां तज्जन्यद्रव्याणां च गुणास्तदर्थाः ॥ १४ ॥

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। १ । तदर्था इति तेषामिन्द्रियाणामर्था विषया इत्यर्थः ॥

। २ । बुद्धिं लक्षयति ॥

बुद्धिरुपलब्धिर्ज्ञानमित्यनर्थान्तरम् ॥ १५ ॥

।१। अनर्थान्तरं समानार्थकमित्यर्थः ॥

।२। मनो लक्षयति ॥

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युगपज्ज्ञानानुत्पत्तिर्मनसो लिङ्गम् ॥ १६ ॥

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।१। युगपदेककाले। एकात्मनीति पूरणीयं। ज्ञानानामनुत्पत्तिर्यतः स एव धर्मो मनसो लिङ्गं लक्षणमित्यर्थः ॥

।२। अत्र मनोनामकं परमाणुपरिमाणं क्रियावदाभ्यन्तरमिन्द्रियम् तच्चात्मना संयुक्तं सद् येन येनेन्द्रियेण यदा यदा संयुज्यते तदा तदिन्द्रियेण ज्ञानं जायते तस्य च परमाणुत्वाद् युगपदनेकेन्द्रियसंयोगाभावेन न युगपन्नानाज्ञानोत्पत्तिरिति गौतममतम्। अस्मन्मतं तु जीवात्मनो युगपन्नानाज्ञानधारणे स्वाभाविकी काचिदशक्तिर्विद्यते तद्विशिष्ट आत्मा मनःपदेन व्यवह्रियत इति ॥

।३। अथ कुप्रवृत्तेरुद्दिष्टाया लक्षणं वक्तव्यं तच्च प्रवृत्तिलक्षणे कृते स्फुटं प्रतीयत इति प्रवृत्तिं लक्षयति विभजतेच ॥

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प्रवृत्तिर्बुद्धिशरीरारम्भः ॥ १७ ॥

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।१। अत्र प्रवृत्तिर्वाग्बुद्धिशरीरारम्भ इति गौतमसूत्रम्। तत्र वागारम्भस्य शरीरारम्भान्तर्गततया पृथगुपन्यासो न कर्तव्य

इत्यभिप्रायेण प्रवृत्तिर्बुद्धिशरीरारम्भ इति सूचितम्। किञ्च यथा प्रवृत्तिर्बुद्धिप्रवृत्तिः शरीरप्रवृत्तिरिति द्विधा तथा तस्या उचितानुचितभेदेनापि द्वैविध्यम् ॥

।२। अथ रागादिलक्षणेऽनुचितरागादिलक्षणं स्फुटमिति रागादि लक्षयति ॥

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प्रवर्त्तनालक्षणं रागादि ॥ १८ ॥

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।१। प्रवर्त्तना प्रवृत्तिहेतुत्वम्। तदेव लक्षणं यस्य तादृशं रागादि। आदिपदाद् द्वेषपरिग्रहः ॥

।२। सांसारिकजीवनं लक्षयति ॥

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ऐहिकदेहेनात्मनः संयोगः सांसारिकजीवनम् ॥ १९ ॥

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।१। स्पष्टम् ॥ फलं लक्षयति ॥

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प्रवृत्तिजनितार्थः फलम् ॥ २० ॥

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।२। दुःखं लक्षयति ॥

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बाधनालक्षणं दुःखम् ॥ २१ ॥

। १ । बाधना पीडा तदेव लक्षणं यस्य तादृशमित्यर्थः ॥

। २ । अथ सकारणं परमपुरुषार्थं दर्शयति ॥

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परमेश्वरप्रसादात् परमः पुरुषार्थः ॥ २२ ॥

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। १ । अत्र तदत्यन्तविमोक्षोऽपवर्ग इति गौतमसूत्रम् । तत्पदं पूर्वोपक्रान्तदुःखपरामर्शकम् अत्यन्तं पुनर्दुःखोत्पत्तिर्यथा न स्यात् तथा विमोक्षो विध्वंसः तथाच पुनर्दुःखोत्पत्तिप्रतिबन्धको दुःखध्वंसः परमपुरुषार्थस्तत्त्वज्ञानेन प्राप्तव्य इति गौतममतम् । अस्मन्मतं तु नैवंविधदुःखध्वंसमात्रं परमपुरुषार्थः तस्याभावरूपतया तुच्छत्वेन स्वतो मनोहरत्वाभावात् किन्तु परमपुरुषार्थे दुःखध्वंसादन्यत् किमपि स्पृहणीयमस्ति यद्वा तद्वा तदस्तु तत् सर्वथा सर्वज्ञस्य जगत्कर्तुः परमदयालोः परमेश्वरस्यैव प्रसादेन तद्भक्तैः प्राप्यमस्तीति ॥

॥ ❋ ॥ २ । समासं प्रमेयप्रकरणम् ॥ ❋ ॥

अथ उद्देशलक्षणमात्रेणात्मादिप्रमेयाणामङ्गीकारो न संभवत्यतस्तत्रोपपत्तिर्निरूपणीया । तन्निरूपणं च न्यायप्रयोगरूपं न्यायस्य च संशयः पूर्वाङ्गमिति क्रमप्राप्तं संशयं लक्षयति ॥

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सामान्यप्रत्यक्षाद्विशेषाप्रत्यक्षाद्विशेषस्मृतेश्च संशयः ॥ २३ ॥

। १ । सामान्यप्रत्यचात् सामान्यधर्मवद्धर्मिग्रहणात् । विशेषाप्रत्यचात् विशेषाणां भेदकधर्माणामग्रहणात् । विशेषस्मृतेः विशेषधर्मस्य स्थाणुत्वपुरुषत्वादेः स्मरणात् संशयो भवति ॥

। २ । अथ प्रयोजनाभावे संशयनिवृत्तये यत्नो न क्रियते । अतः क्रमप्राप्तं प्रयोजनं लक्षयति ॥

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यमर्थमधिकृत्य प्रवर्त्तते तत्प्रयोजनम् ॥ २४ ॥

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। १ । अधिकृत्य उद्दिश्य तथाच प्रवृत्तिहेत्विच्छाविषयः प्रयोजनमित्यर्थः ॥

। २ । अथ दृष्टान्ताभावे सिद्धान्ताभावे वा उपपत्त्यसंभवात् क्रमप्राप्तं दृष्टान्तं लक्षयति ॥

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लौकिकपरीक्षकाणां यस्मिन्नर्थे
बुद्धिसाम्यं स दृष्टान्तः ॥ २५ ॥

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। १ । अत्र लौकिकाः प्रतिपाद्याः । परीक्षकाः प्रतिपादकाः । तेषां यस्मिन्नर्थे बुद्धिसाम्यं ज्ञानाविरोधो भवति स दृष्टान्त इत्यर्थः । तथाच वादिप्रतिवादिनिश्चयविषयो दृष्टान्त इत्याशयः । यथा वह्निसाधने महानसं वह्न्यभावसाधने महाह्रद इति ॥

। २ । समाप्तं न्यायपूर्वाङ्गप्रकरणम् ॥

। ३ । क्रमप्राप्तं सिद्धान्तं लक्षयति ॥

तन्त्राधिकरणाभ्युपगमसंस्थितिः सिद्धान्तः ॥ २६ ॥

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। १ । विभजते ॥

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सर्वतन्त्रप्रतितन्त्राधिकरणाभ्युपगमसंस्थितीना-
मर्थान्तरभावात् ॥ २७ ॥

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। १ । सर्वतन्त्रसिद्धान्तं लक्षयति ॥

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सर्वतन्त्राविरुद्धस्तन्त्रेऽधिकृतः सर्वतन्त्रसि-
द्धान्तः ॥ २८ ॥

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। १ । यथा गन्धादयो घ्राणादीन्द्रियग्राह्या इति ॥
। २ । प्रतितन्त्रसिद्धान्तं लक्षयति ॥

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समानतन्त्रसिद्धः परतन्त्रासिद्धः प्रतितन्त्रसि-
द्धान्तः ॥ २९ ॥

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। १ । यथेङ्गलण्डीयानां भूभ्रमणमिति ॥
। २ । अधिकरणसिद्धान्तं लक्षयति ॥

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यत्सिद्धावन्यप्रकरणसिद्धिः सोऽधिकरणसि-
द्धान्तः ॥ ३० ॥

। १ । यथा प्रपञ्चस्य जन्यत्वे साध्यमाने परमेश्वरस्य सर्वज्ञत्वम् ॥

। २ । अभ्युपगमसिद्धान्तं लक्षयति ॥

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अपरीक्षिताभ्युपगमात् तद्विशेषपरीक्षणमभ्यु-
पगमसिद्धान्तः ॥ ३१ ॥

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। १ । यथा गौतमेनाभ्युपगतं मनस इन्द्रियत्वमिति ॥

। २ । समाप्तं न्यायाश्रयसिद्धान्तप्रकरणम् ॥

। ३ । क्रमप्राप्तानवयवान् लक्षयितुं विभजते ॥

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प्रतिज्ञाहेतूदाहरणोपनयनिगमनान्यव-
यवाः ॥ ३२ ॥

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। १ । प्रतिज्ञां लक्षयति ॥

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साध्यनिर्देशः प्रतिज्ञा ॥ ३३ ॥

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। १ । यथा भूर्गोलाकृतिरिति ॥

। २ । क्रमप्राप्तं हेतुं लक्षयति विभजते च सूत्राभ्याम् ॥

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उदाहरणसाधर्म्यात्साध्यसाधनं
हेतुः तथा वैधर्म्यात् ॥ ३४ ॥

। १ । अत्र साध्यसाधनं हेतुरिति सामान्यलक्षणम् । तस्य द्वैविध्यमाह उदाहरणसाधर्म्यात् तथा वैधर्म्यादिति । यथा उक्तसाध्ये नियतगोलच्छायावत्त्वात् । यत् नियतगोलच्छायकं तत् गोलं दृष्टं यथा कन्दुक इति । यथा वा नियतगोलच्छाया-वत्त्वात् । यद्गोलं न भवति न तत् नियतगोलच्छायकं यथा स्तम्भ इति ॥

। २ । क्रमप्राप्तमुदाहरणं लक्षयति ॥

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साध्यसाधर्म्यात्तद्धर्मभावी दृष्टान्त उदाहरणम् ॥ ३५ ॥

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। १ । यथा यद्यत् नियतगोलच्छायकं तद्गोलाकृतिकं यथा कन्दुक इति ॥

। २ । व्यतिरेक्युदाहरणं लक्षयति ॥

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तद्विपर्ययाद्वा विपरीतं व्यतिरेक्युदाहरणम् ॥ ३६ ॥

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। १ । यद्गोलं न भवति न तत् नियतगोलच्छायकं यथा स्तम्भ इति ॥

। २ । क्रमप्राप्तमुपनयं लक्षयति ॥

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उदाहरणापेक्षस्तथेत्युपसंहारो न तथेति
वा साध्यस्योपनयः ॥ ३७ ॥

। १ । साध्यस्य पक्षस्य उदाहरणापेक्षः उदाहरणानुसारीय उपसंहारः उपन्यासः स उपनयावयव इत्यर्थः । स द्विविधोऽन्वयिव्यतिरेकिभेदात् । तथेति साध्यस्योपसंहारोऽन्वय्युपनयः । यथा तथाचेयं भूः । न तथेति साध्यस्योपसंहारो व्यतिरेक्युपनयः । यथा नचेयं भूस्तथेति ॥

। २ । निगमनं लक्षयति ॥

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हेत्वपदेशात्प्रतिज्ञायाः पुनर्वचनं निगमनम् ॥ ३८ ॥

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। १ । यथा तस्माद्गोलाकारा भूरिति ॥

। २ । समाप्तं न्यायस्वरूपप्रकरणम् ॥

। ३ । क्रमप्राप्तं तर्कं लक्षयति ॥

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अविज्ञाततत्त्वेऽर्थे कारणोपपत्तितस्तत्त्वज्ञानार्थमूहस्तर्कः ॥ ३९ ॥

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। १ । यथा यदि भूर्गोलाकृतिर्न स्यात्तर्हि नियतगोलच्छाया न स्यात् ॥

२ । क्रमप्राप्तं निर्णयं लक्षयति ॥

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विमृश्य पक्षप्रतिपक्षाभ्यामर्थावधारणं निर्णयः ॥ ४० ॥

। १ । विमृश्य सन्दिह्य पक्षप्रतिपक्षाभ्यां स्वपक्षस्थापनपर-पक्षदूषणाभ्यां अर्थावधारणं निर्णय इत्यर्थः ॥

॥ ❋ ॥ समाप्तं न्यायोत्तराङ्गप्रकरणम् ॥ ❋ ॥

अथ तर्कानन्तरं साधुस्तत्त्वजिज्ञासुर्वादमन्तरा कदाचिन्निर्णयं न प्राप्नोतीति क्रमप्राप्तं वादं लक्षयति ॥

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प्रमाणतर्कसाधनोपालम्भः सिद्धान्ताविरुद्धः पञ्चा-
वयवोपपन्नपक्षप्रतिपक्षपरिग्रहो वादः ॥ ४१ ॥

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। १ । जिगीषया हि धूर्तास्तत्त्वजिज्ञासाच्छलेन जल्पं कुर्वन्तीति क्रमप्राप्तं जल्पं लक्षयति ॥

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यथोक्तोपपन्नः छलजातिनिग्रहस्थानसाध-
नोपालम्भो जल्पः ॥ ४२ ॥

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। १ । तथाचोभयपक्षस्थापनावती विजिगीषुकथा जल्प इत्याशयः ॥

। २ । धूर्ता अपि जल्पासमर्था वितण्डां कुर्वन्तीति क्रमप्राप्तां वितण्डां लक्षयति ॥

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स प्रतिपक्षस्थापनाहीनो वितण्डा ॥ ४३ ॥

॥ ❋ ॥ समाप्तं कथाप्रकरणम् ॥ ❋ ॥

अथ जल्पकादयः स्वमतरक्षणाय सद्धेतुमप्राप्य बुद्धिपूर्वं हेत्वाभासान् प्रयुञ्जते तेषां निग्रहार्थमेवं हेत्वाभासस्वरूपज्ञानाभावे साधवोऽपि हेत्वाभासप्रयोगं कुर्युस्तद्वारणार्थं क्रमप्राप्तान् हेत्वाभासान् लक्षयति विभजते च ॥

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सव्यभिचारविरुद्धप्रकरणसमसाध्यसमा-
तीतकाला हेत्वाभासाः ॥ ४४ ॥

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। १ । सव्यभिचारं लक्षयति ॥

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अनैकान्तिकः सव्यभिचारः ॥ ४५ ॥

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। १ । यथा पर्वतो धूमवान् वह्नेरिति ॥
। २ । क्रमप्राप्तं विरुद्धं लक्षयति ॥

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सिद्धान्तमभ्युपेत्य तद्विरोधी विरुद्धः ॥ ४६ ॥

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। १ । यथा वह्निमान् ह्रदत्वादिति ॥
। २ । क्रमप्राप्तं प्रकरणसमं लक्षयति ॥

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यस्मात्प्रकरणचिन्ता स निर्णयार्थ-

सपदिष्टः प्रकरणसमः ॥ ४७ ॥

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। १ । यथा शब्दो नित्यः शब्दत्वात् । शब्दोऽनित्यः कृतकत्वादिति ॥

। २ । क्रमप्राप्तं साध्यसमं लक्षयति ॥

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साध्याविशिष्टश्च साध्यत्वात्साध्यसमः ॥ ४८ ॥

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। १ । यथा शब्दो गुणश्चाक्षुषत्वादिति ॥

। २ । क्रमप्राप्तमतीतकालं लक्षयति ॥

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कालात्ययापदिष्टः कालातीतः ॥ ४९ ॥

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। १ । यथा वह्निरनुष्णः कृतकत्वादिति ॥

। २ । समाप्तं हेत्वाभासप्रकरणम् ॥

। ३ । हेत्वाभासान् साधुरपि भ्रमादेव प्रयुङ्क्ते इत्युक्तम् ॥ अथ धूर्त्तमात्रप्रयुक्तं क्रमप्राप्तं छलं लक्षयति ॥

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वचनविघातोऽर्थविकल्पोपपत्त्या छलम् ॥ ५० ॥

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। १ । छलं विभजते ॥

तत्त्रिविधं वाक्छलं सामान्यच्छलमुप-
चारच्छलं च ॥ ५१ ॥

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वाक्छलादिभेदात् त्रिविधं छलमित्यर्थः ॥

। १ । वाक्छलं लक्षयति ॥

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अविशेषाभिहितेऽर्थे वक्तुरभिप्रायाद-
र्थान्तरकल्पना वाक्छलम् ॥ ५२ ॥

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। १ । यथा गौर्विषाणीत्युक्ते कुतो गजस्य शृङ्गमिति ॥

। २ । सामान्यच्छलं लक्षयति ॥

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सम्भवतोऽर्थस्यातिसामान्ययोगादसम्भ-
तार्थकल्पना सामान्यच्छलम् ॥ ५३ ॥

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। १ । यथा ब्राह्मणोऽयं विद्याचरणसम्पन्न इत्युक्ते कथमस्य विद्याचरणसम्पन्नत्वं बाल्ये व्यभिचारादिति ॥

। २ । उपचारच्छलं लक्षयति ॥

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धर्मविकल्पनिर्देशेऽर्थसद्भावप्रतिषेध उपचार-
च्छलम् ॥ ५४ ॥

। १ । यथा मञ्चाः क्रोशन्तीत्युक्ते मञ्चस्थपुरुषाः क्रोशन्ति नतु मञ्चा इति ॥

। २ । प्रसङ्गात् छलं पूर्वपक्षयति ॥

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वाक्छलमेवोपचारच्छलं तदविशेषात् ॥ ५५ ॥

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। १ । तथाच द्विविधमेव छलमित्यर्थः ॥

। २ । समाधत्ते ॥

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न तदर्थान्तरभावात् ॥ ५६ ॥

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। १ । विपक्षे बाधकमाह ॥

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अविशेषे वा किञ्चित्साधर्म्यादेकच्छलप्रसङ्गः ॥ ५७ ॥

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॥ ❋ ॥ समाप्तं छलप्रकरणम् ॥ ❋ ॥

क्रमप्राप्तां जातिं लक्षयति ॥

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साधर्म्यवैधर्म्याभ्यां प्रत्यवस्थानं जातिः ॥ ५८ ॥

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। १ । व्याप्तिनिरपेक्षाभ्यां साधर्म्यवैधर्म्याभ्यां प्रत्यवस्थानं दूषणाभिधानं जातिरित्यर्थः ॥

। २ । क्रमप्राप्तं निग्रहस्थानं लक्षयति ॥

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विप्रतिपत्तिरप्रतिपत्तिश्च निग्रहस्थानम् ॥ ५९ ॥

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। १ । जातिनिग्रहस्थानयोर्विभागो नास्तीति भ्रमवारणायाह ॥

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तद्विकल्पाज्जातिनिग्रहस्थानबहुत्वम् ॥ ६० ॥

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। १ । विस्तरभयात् तद्विभागो नात्र क्रियते ॥

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। २ । इति श्रीमज्जेम्स्वालण्टैनविरचितायां न्यायकौमुद्यां गौतमोक्तपदार्थमालया नव्ययुरोपीयमतसिद्धपदार्थमालायाः साम्यविरोधयोर्दर्शनं नाम प्रथमोऽध्यायः समाप्तः ॥

॥ ❋ ॥ ———————— ॥ ❋ ॥

। १ । तदेवं प्रथमेऽध्याये कः परमपुरुषार्थः किञ्च तस्य साधनमिति विचारे गौतममतेन स्वमतस्य साम्यविरोधौ प्रदर्शितौ सङ्क्षेपेण ॥

। २ । अथ स्वाभिमतक्रमविशिष्टं विद्याटन्दं निरूपयितुमारभते ॥

। ३ । तत्र सर्वप्रमेयसिद्धेः प्रमाणाधीनतया प्रथमाध्यायस्य

प्रथमसूत्रे प्रथममुद्दिष्टानां तृतीयसूत्रे विभक्तानां प्रमाणानां विभागक्रमेण परीक्षणं प्रसङ्गप्राप्तमिति प्रथमं प्रत्यक्षप्रमाणभूतानि द्वादशसूत्रोक्तानि पञ्च घ्राणादीनीन्द्रियाणि निरूपयति । तत्तदिन्द्रियप्रकरणे च तत्तदिन्द्रियार्थानां गन्धरसरूपस्पर्शशब्दानां विषये यत् परीक्षया सम्यङ् निश्चितं तदेव वक्ष्यति ॥

। ४ । तत्र प्रथमोद्दिष्टं घ्राणेन्द्रियं लक्षयति ॥

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जिघ्रामीतिप्रत्ययोत्पादिका शक्तिर्घ्राणेन्द्रियं नासावर्ति ॥ १ ॥

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। १ । तत्र गन्धवत्पदार्थांशाः श्वासद्वारा यदा नासां प्रविशन्ति तदा प्रतिबन्धकाभावे शरीरावयवनिष्ठयच्छक्तिवशात् जिघ्रामीति ज्ञानमुत्पद्यते सा शक्तिर्घ्राणेन्द्रियम् ॥

। २ । घ्राणस्य विषयो गन्धः स च यादृशशक्तिमतामेव पदार्थानां घ्राणेन्द्रियाख्यशक्तिमता शरीरावयवेन संयोगे जिघ्रामीति ज्ञानं भवति तादृशः शक्तिविशेषः । तथाचैवंविधशक्तिविशेषवतामेव गन्धवत्त्वेन व्यवहारो न तु पृथिव्या एव गन्धवत्त्वमिति नियमः । तादृशनियमबलेन हरितवाय्वाद्युत्कटगन्धवदमिश्रद्रव्याणां पृथ्वीत्वेन व्यवहारे फलाभावात् । शास्त्रे च तत्तत्संज्ञया तत्तत्पदार्थानां व्यवहारे फलस्यावश्यापेक्षितत्वात् ॥

। ३ । येन येन पदेन यस्य यस्य वस्तुनो व्यवहारो लौ-

किककार्यसम्बद्ध्यनुकूलो भवति तानि पदानि वस्तूनि च रसाय-
नप्रकरणादवगन्तव्यानि ॥

। ४ । अथ क्रमप्राप्तं रसनेन्द्रियं लक्षयति ॥

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आस्वादयामीतिप्रत्ययोत्पादिका शक्ती रसनेन्द्रियं
जिह्वावर्ति ॥ २ ॥

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। १ । तत्र मुखं प्रविष्टा रसवत्पदार्था मुखजलसंयोगेन द्रुताः सन्तो यदा जिह्वया संयुज्यन्ते तदा प्रतिबन्धकाभावे आस्वादयामीति ज्ञानमुत्पद्यते । रसनस्य विषयो रसः । तत्स्वरूपं तु पूर्वोक्तगन्धस्वरूपवत् शक्तिविशेषरूपं ज्ञेयम् ॥

। २ । अथ क्रमप्राप्तं चक्षुरिन्द्रियं लक्षयति ॥

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पश्यामीतिप्रत्ययोत्पादिका शक्तिश्चक्षुरिन्द्रियं ने
त्रवर्ति ॥ ३ ॥

। १ । तथाहि स्वतः प्रकाशात् परतः प्रकाशाद् वा यस्मात् पदार्थादागतं यादृशरूपप्रत्यायनशक्तिमत् तेजो नेत्रं विशति तादृशरूपविशिष्टत्वेन तत्पदार्थस्य चाक्षुषं ज्ञानं भवति । चक्षुषो विषयो रूपं । तेजःस्वरूपं तेजोरूपयोः सम्बन्धस्ते-

जसस्तत्तद्द्रव्यसंयोगजन्या अवस्थाविशेषा नेत्रघटकावयवव्यवस्था च दृग्विद्याप्रकरणे विवेचयिष्यते ॥

। २ । अथ क्रमप्राप्तं त्वगिन्द्रियं लक्षयति ॥

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स्पृशामीतिप्रत्ययोत्पादिका शक्तिस्त्वगिन्द्रियं सर्वशरीरवर्तिनोऽप्यस्याङ्गुल्यग्रेषूत्कर्षः ॥ ४ ॥

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। १ । अथ क्रमप्राप्तं श्रोत्रेन्द्रियं लक्षयति ॥

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शृणोमीतिप्रत्ययोत्पादिका शक्तिः श्रोत्रेन्द्रियं कर्णवर्ति ॥ ५ ॥

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। १ । तत्र कर्णमृदङ्गाख्यायाः कर्णवर्तित्वचः श्रवणानुकूलात् स्पन्दनात् शृणोमीति प्रत्ययो जायते । श्रोत्रस्य शब्दो विषयः । शब्दस्य स्वरूपं शब्दोत्पत्तिस्थानद्रव्यविशेषस्पन्दनस्य वाय्वादिद्वारा कर्णवर्तित्वक्स्पन्दनोत्पादकत्वं कर्णघटकावयवव्यवस्था च श्रुतिविद्याप्रकरणे विवेचयिष्यते ॥

। २ । एवं पञ्चेन्द्रियाणि पञ्चभिस्तद्विषयैः सह निरूपितानि अथ दूरत्वस्य प्रत्यक्षविषयत्वेन लोकैरभिमन्यमानस्य वास्तविकं ग्राहकमाह ॥

दूरत्वज्ञानमनुमानान्न प्रत्यक्षात् ॥ ६ ॥

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। १ । तथाहि यस्य पदार्थस्य रूपमवयवाश्चास्फुटं प्रतीयन्ते यस्य च परिमाणं पूर्वनिर्णीततदीयवास्तविकपरिमाणादपकृष्टत्वेन गृह्यते तस्य दूरत्वमनुमीयते । यथा मन्दिरान्तर्गतेन पुरुषेणैकहस्तायतगवाक्षद्वारेण विलोक्यमानो गङ्गापरतीरवर्ती विंशतिहस्तायतस्तालतरुः प्रथमं तद्गवाक्षपरिमाणादपकृष्टपरिमाणवत्त्वेन गृह्यते तस्य रूपं शाखापत्रफलादयोऽवयवाश्चास्फुटं प्रतीयन्त इति तस्य वास्तविकं दूरत्वं तल्लक्षणादनुमीयते । यथा वा यदा कश्चित् समीपवर्ती काको निविडमिहिकाव्यवधानादस्पष्टो दृश्यते तदा यदि स काकत्वेन न गृह्यते किन्तु गजत्वेन तर्हि पूर्वनिश्चितगजपरिमाणादपकृष्टपरिमाणवत्तया ज्ञानादयं सुदूरवर्ती गज इत्यनुमीयते सति तु काकत्वज्ञाने वास्तविकं तस्य समीपत्वं गृह्यते । यत्र तु वास्तविकं परिमाणं न पूर्वं विज्ञातं नचास्फुटं प्रतीतिस्तत्र न वास्तविकदूरत्वनिश्चयः । यथा सूर्यचन्द्रतारकाणां एषां हि वास्तविकं परिमाणं न पूर्वं विज्ञातं नचैषां प्रतीतिरस्फुटं भवति तेषामतिभास्वरत्वात् । अतएव वितस्तिमात्रौ सूर्याचन्द्रमसौ तारकाश्चामलकमात्रा इति साधारणी सर्वेषां प्रतीतिः । अतएव च सर्वेषां तेषां भूगोलात् समानेऽन्तरे ग्रहणं येन नक्षत्रसंस्थाया वृत्तत्वप्रतीतिरिति ॥

। २ । एवमेव शब्दकारणस्य दूरत्वं श्रोत्रेण गृह्यत इति यल्लौकिकं मतं तदविचारमूलकं । तथाहि । यदि तावच्छब्द-प्रत्यक्षमेव तस्य दूरात्समीपाद्वाप्राप्तत्वं गृह्णीयात् तर्हि शब्दविशेषे किमयं घरट्टशब्द उत मेघगर्जितमिदमिति सन्देहः कथं स्यात् । अत एवं स्वीकर्तव्यं । शब्दानां यदि तत्तत्कार-णजन्यता ज्ञायते तर्हि तेषां तारत्वेन मन्दत्वेन च श्रोत्रप्रत्यक्ष-विषयेण तत्कारणस्य सामीप्यं दूरत्वं चानुमीयते । यथा यदि क-श्चिद् रात्रावतिमन्दं शब्दं शृण्वन् घनगर्जितमिदमिति मित्रवा-क्यादवगच्छति तदा घनानां सुदूरत्वमनुमिनोति । तत्तत्कारण-जन्यत्वस्यानिश्चये तु तारत्वमन्दत्वादिज्ञानादुक्तप्रकारकः सन्दे-हो जायते । तथाचोभयत्रापि दूरत्वमनुमानगम्यमेवेति स्पष्टम् ॥

। ३ । ननु निरूपितानि घ्राणरसनचक्षुस्त्वक्श्रोत्रभेदेन पञ्चेन्द्रियाणि सन्ति शरीरावयवविशेषद्वारा स्वस्वविषयसन्निकर्षे युगपज्ज्ञानपञ्चकं किमिति न जनयन्तीति चेदत्र गौतमीयाः न ज्ञानानां यौगपद्यं सम्भवति इन्द्रियार्थसन्निकर्षमात्रस्य ज्ञान-कारणत्वाभावात् किन्तु आत्मा मनसा मन इन्द्रियेणेन्द्रियमर्थेन यदा संयुज्यते तदा ज्ञानमुत्पद्यते बहूनामिन्द्रियार्थसन्निकर्षा-णां युगपत् सम्भवेऽपि परमाणुभूतस्याभ्यन्तरेन्द्रियस्य मनसो नानेन्द्रियैर्युगपत् संयोगासम्भवादेव न नानाज्ञानयौगपद्यमित्या-हुः । नव्ययुरोपीयास्तु मनो नाम नात्मव्यतिरिक्तमाभ्यन्तर-मिन्द्रियं किन्त्वेतच्छरीरावच्छिन्नस्थितिक आत्मैव मनः शब्देन

लाघवाद्यवहर्त्तव्यः तथाविधस्य चात्मनो न युगपन्नानाज्ञानशा-लित्वे शक्तिस्तथाच सत्यपि नानेन्द्रियार्थसन्निकर्षे स्वाभावि-काशक्तिविशेषस्य प्रतिबन्धकत्वान्न ज्ञानयौगपद्यमित्याहुः ॥

। ४ । अथैतच्छरीरावच्छिन्न आत्मनि नानाविधा विशेष-गुणाः सन्ति तान् संक्षेपेण निदर्शयति ॥

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सुखदुःखप्रणिधानस्मरणप्रभृतयो
मनसो विशेषगुणाः ॥ ७ ॥

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। १ । एतेषां गुणानां विस्तरेण वर्णनं ग्रन्थान्तरे द्रष्टव्यम् ॥

। २ । अथ दूरत्वस्य निश्चयोऽनुमानाद् भवति न प्रत्य-क्षादिति यदुक्तं तत्प्रसङ्गात् क्रमप्राप्तमनुमानं निरूपयितुं प्रत्य-क्षप्रकरणोत्तरमनुमानप्रकरणमारभते । तस्यावान्तरप्रकरणा-नि चत्वारि प्रथमं व्याप्तिग्रहोपायप्रकरणम् द्वितीयं स्वार्थानुमा-नप्रकरणम् तृतीयं परार्थानुमानप्रकरणम् चतुर्थं वादप्रकरण-मिति । तत्रादावनुमानस्य स्वरूपलक्षणमाह सूत्रेण ॥

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व्याप्तिनिश्चयोऽनुमानम् ॥ ८ ॥

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। १ । तत्र नियतं साहचर्यं व्याप्तिः यथा यत्र यत्र धूमस्त-त्र वह्निरित्यादि ॥

। २ । अथ विनोपायमेवंविधव्याप्तेर्निश्चयस्याशक्यतया तदु-

पायो वक्तव्यः स च न तत्तद्वस्तुप्रत्यक्षमात्रं निर्विचारस्य तस्याप्रयोजकत्वात् । नापि केवलो विचारो विना वस्तुधर्मप्रत्यक्षं तस्याप्यप्रयोजकत्वात् । अपितु परस्परसहकृतं तदुभयं हेतुरित्याशयेनाह ॥

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प्रत्यक्षं विचारश्च तस्य मूलम् ॥ ९ ॥

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। १ । तस्येति व्याप्तिनिश्चयस्येत्यर्थः ॥

। २ । अथ व्याप्तिनिश्चयमूलभूतं प्रत्यक्षं विभजते ॥

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प्रतीक्षा परीक्षा चेति द्विविधं प्रत्यक्षम् ॥ १० ॥

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। १ । प्रतीक्षा नाम यत्र विषये दिदृक्षिततत्तत्कार्यघटनानुकूलक्रिया पौरुषी न सम्भवति तत्र पुरुषेण क्रियमाणं निश्चलया बुद्ध्या तत्तत्कार्यदर्शनं । यथा सूर्यचन्द्रग्रहणादौ । तत्र हि स्वकृत्यसाध्येन चन्द्रपृथिव्योस्तत्तत्काले तत्तद्देशसम्बन्धेनोत्पद्यमानं ग्रहणं केवलं द्रष्टव्यमेवेत्ययं केवलायाः प्रतीक्षाया विषयः ॥

। २ । परीक्षा नाम दिदृक्षिततत्तत्कार्यघटनानुकूलया पुरुषक्रियया निर्वर्तितानां तत्तत्कार्याणां दर्शनम् । यथा गन्धकलवणादीनामग्निजलापेक्षधर्मविशेषजिज्ञासायां गन्धकादेरग्न्यादिना सह सम्बन्धं विधाय तत्तत्कार्यभूतधर्माणां दर्शनमित्येष परीक्षाविषयः ॥

। ३ । ननु उक्तविधप्रतीक्षापरीक्षयोर्लोकसिद्धत्वात् किं तदुपदेशाय ग्रन्थेनेत्याशङ्कां निराचिकीर्षुस्तयोर्लोकसिद्धत्वेऽपि तत्सम्बन्धिन्या इतिकर्तव्यताया लोकसिद्धत्वाभावादितिकर्तव्यतान्तर्गतानां बुद्धिवृद्धिनियमसाधनानामुपदेशस्यावश्यकत्वाद्ग्रन्थः सार्थक इत्याशयेन बुद्धेः स्वसहकार्यपेक्षामाह ॥

बाह्ये कार्ये हस्तादीनां स्वस्वसहकार्यपेक्षावद्
बुद्धेः स्वकार्ये सहकार्यपेक्षा सिद्धैव ॥ ११ ॥

। १ । सिद्धैवेति । सकलसहकारिसमवधाने सति यावन्तो विशेषाः कार्ये उत्पद्यन्ते न तावन्तः सहकारिवैकल्ये सति । नहि केवलेन हस्तेन निर्मिते दण्डचक्रचीवरजलप्रभृतिसकलोपकरणसहितेन च हस्तेन निर्मिते घटादौ समाना एव विशेषा भवन्ति । यदि समाना एव स्युस्तर्हि विविधधातुकाष्ठमयान्यनेकप्रकाराणि साधनानि निरर्थकान्येव स्युरिति तावद् निर्विवादं । तेन चेदमप्यनुमातुं शक्यते । यथा । बुद्धिर्विशिष्टकार्यजनने सहकारिसापेक्षा एकाकितादशायां केवलं क्षुद्रकार्यजनकत्वाद् हस्तवदिति । ते तु बुद्धेः सहकारिणोऽग्रे निरूपयिष्यन्ते ॥

। २ । अथ यथा प्रतीक्षास्थले तत्तत्कार्यदर्शनमात्रं शक्यं तथा परीक्षास्थलेऽपि तत्तत्कार्यांशे मनुष्यस्य शक्तिर्नास्त्येव

किन्तु तेन तत्तत्कार्यदर्शनमेव कर्तव्यम् । इयांस्तु विशेषो यत् परीक्षास्थले तत्तत्कार्यानुकूलपदार्थानामेकत्र संग्रहो वा दूरीकरणं वा कर्तुं शक्यत इत्याह ॥

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कार्यकरणप्रवृत्तेन पुरुषेण सिद्धवस्तूनां संयोजनवियोजनाभ्यामन्यन्न किमपि कर्तुं शक्यते फलस्य प्रकृतिमात्राधीनत्वात् ॥ १२ ॥

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। १ । प्रकृतिमात्राधीनत्वादिति प्रकृतिमात्रस्येश्वरेच्छामात्रस्य जगत्स्वभावमात्रस्य वा ऽधीनत्वादित्यर्थः ॥

। २ । अथ बुद्धेस्तत्त्वज्ञानानुकूलसहकारिसम्पादनस्यावश्यकतां द्रढयितुं सहकारिविरहितया बुद्ध्या विचारे क्रियमाणे यदनिष्टं सम्पद्यते तदाह ॥

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प्रायः सर्वेषु विद्याभेदेषु स्वल्पफलताया बीजमिदमेव यज्जिज्ञासवो लोका बुद्धिवृद्धिसहकारिसाधनान्वेषणमुपेक्ष्य स्वीयबुद्धेरलौकिकसामर्थ्याभिमानेन प्रवर्तन्ते ॥ १३ ॥

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। १ । अयं भावः । यदि कश्चिच्चित्रकारः स्वीयकौशलातिशयगर्ववशाद् बिम्बमनवलोक्यैव प्रतिबिम्बनिर्माणे प्रवर्तते तर्हि तस्याभिमानित्वमयथार्थकारित्वं च यथा स्पष्टीभवति तथा

यदि कश्चिज्जिज्ञासुरात्मानं केवलबुद्धिसाहाय्येन प्रकृतिप्रवाहावगाहने समर्थं मन्यमानो निरूपितस्वरूपयोः प्रतीच्यापरीच्ययोरनादरं कुर्यात् तर्हि तस्याप्यभिमानित्वमयथार्थकारित्वं च स्पष्टमेव स्यात् कथं च सर्वपदार्थतत्त्वज्ञानफलिकां विद्यां स प्राप्नुयात् न कथमपीति ॥

। २ । अथातिशयिततीक्ष्णबुद्धीनामपि सुबहुविचारतत्पराणामपि पुरुषाणां केवलया बुद्ध्या सर्वतत्त्वज्ञानसम्पादनं कदापि न सम्भवति प्रकृतितत्त्वस्य परमसूक्ष्मत्वादित्याह ॥

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यावतीं विषयनिष्ठां सूक्ष्मतां साक्षात्कर्तुं विचारयितुं च केवलानामिन्द्रियाणां केवलाया बुद्धेश्च शक्तिरस्ति ततोऽधिकतरा सूक्ष्मता प्रकृतितत्त्वस्यास्त्येव अतो ये ये विचारा विवादाश्च समीचीनं तत्त्वज्ञानोपायमनादृत्य प्रवर्तन्ते ते सर्वे प्रकृतितत्त्वसंस्पर्शाभावाद् व्यर्था एव तेषां व्यर्थत्वज्ञानमपि महता समीचीनतत्त्वज्ञानोपायानुसारिणा विचारेण विना न शक्यम् ॥ १४ ॥

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। १ । सूक्ष्मतरं प्रकृतितत्त्वमस्त्येवेति । यथा प्राचीने काले परस्सहस्राः पण्डिताः सर्वदा प्रकृतितत्त्वविचारतत्परा आसन् ते च पामरजनसाधारणस्य चाक्षुषेण रासनेन च प्रत्यक्षेण दृढी-

कृतस्यापि वस्तुतो बाधितस्य जलगतामिश्रद्रव्यताविषयकमतस्य पक्षपातिनो बभूवुः । तत्र च हेतुरयमेव यत् ते पण्डिताः सहकारिविरहितैरप्यस्माकमिन्द्रियैर्बुद्ध्या च प्रकृतितत्त्वं निश्चेतुं शक्यमिति कृतनिश्चयाः सम्पूर्णप्रकृतितत्त्वज्ञाने सम्पादनीये बुद्धेरिन्द्रियाणां च यथार्थानि सहकारीणि नानुसृतवन्त इति । अधुनातनैः पुनः प्रतिदिनं प्रतीक्षापरीक्षयोः सहकारेण तत्तद्वस्तुतत्त्वं जिज्ञासमानैः पण्डितैर्जलं मिश्रिताभ्यां द्वाभ्यां वायुभ्यां जनितमस्तीति व्यवस्थापितम् । अत उक्तप्राचीनमतपक्षपातप्रवृत्तनिखिलविवादवैयर्थ्यं स्पष्टमेव जलस्य मिश्रद्रव्यतायाः सहस्रशः परीक्षासहकृतप्रत्यक्षैः समर्थनस्य वास्तविकत्वात् नचेदं सम्यग्विचारमन्तरा सुबोधम् ॥

। २ । ननु यदि प्रतीक्षापरीक्षयोरनादरे प्रकृतितत्त्वं दुर्ज्ञेयमेव तर्हि ये कदाचिदपि प्रतीक्षापरीक्षे न कृतवन्तोऽपि सुबहुतत्त्वज्ञानविशिष्टा उपलभ्यन्ते ते किं भ्रान्ता एवेति चेत् सम्भवत्येतदित्याह ॥

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मनुजजातिसम्बन्धिज्ञानविषयीभूतानां सत्यत्वेनाभिमानविषयाणां स्वरूपाभासानां सर्वांशयथार्थेश्वरीयज्ञानविषयाणां तत्तत्कार्यजातवृत्तिवास्तविकधर्माणां च महद्वैलक्षण्यमस्ति ॥ १५ ॥

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। १ । अथ कथं तत्त्वज्ञानं प्राप्तव्यमित्याकाङ्क्षायां तत्त्वज्ञापकत्वाभिमतं रीतिद्वयं प्राप्नोति तत्रैका न स्वीकर्तुमुचिता साधुत्वाभावात् अन्या त्वनुसर्तव्या साधुत्वादिति सूचयितुं तयोर्द्वयोर्व्यवहारसौकर्यसिद्धये साधुत्वासाधुत्वसूचके नामनी निर्द्दिशति ॥

स्वभावतः सर्वजनानुसृता साहसिक्यपक्षा च रीतिः प्रकृत्याग्रह इत्युच्यते तत्तत्पदार्थगतानां वास्तविकानां सुबहूपयोगानां धर्माणां तत्त्वनिर्णयस्य जनिका रीतिस्तु प्रकृत्यध्ययनमित्युच्यते ॥ १६ ॥

। १ । ननु प्रकृत्याग्रहो यदि दुष्टस्तर्हि किमर्थं प्रायशो लोकैर्व्यवह्रियत इति चेत् स्वल्पायासत्वेन जनमनोवशीकरणक्षमत्वादित्याह ॥

पुरुषबुद्धिवशीकरणे प्रकृत्याग्रहस्यैवाधिकं सामर्थ्यं यतस्तद्विषयीभूताः पदार्थाः प्रतिदिनव्यवहारविषयत्वेन सुप्रसिद्धत्वादत्यल्पत्वाच्च बहुतरमनोयोगनिरपेक्षतया शीघ्रमेव बुद्धौ प्रविशन्ति नत्वेवं प्रकृत्यध्ययनस्य । तद्विषयीभूतपदार्थानां परस्परविलक्षणतया परस्परस्मारकत्वाभावात् संख्यापरिच्छेदाभावात् सर्वजनसाधारण्येन सुबोधत्वाभावाच्च

सहसा बुद्धौ प्रवेशानर्हत्वात् प्रत्युत चिरकालिकेन पूर्वगृहीतविरुद्धमतसंस्कारेण प्रायो लोकानां मनस्यप्रामाणिकत्वेनैव भानात् ॥ १७ ॥

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। १ । एतत्सूत्रोक्तं प्रकृत्याग्रहस्य झटिति लोकवशीकरणक्षमत्वं प्रकृत्यध्ययनस्य च पूर्वसंस्कारवशादप्रामाणिकत्वेन ग्रहणं प्रालेयोदाहरणप्रदर्शनेन स्पष्टीक्रियते । तथाहि । मेघमण्डलविनिर्मुक्तगगनायां स्फुटप्रतीयमाननिखिलनक्षत्रचक्रायां निशायामपयातायां प्रभाते तरुमन्दिरादिप्रदेशानन्तरितायां भुवि जलक्लिन्नतामवलोक्य नूनं नक्षत्रगणाद्गगनादेववेदमुदकं पतितमिति प्रायशः सर्वैः कल्पकैः कल्पितम् । तत्तु तत्कल्पनाविषयभूतानां मेघगगननक्षत्रनिशाप्रभाततरुमन्दिरोदकादीनां प्रतिदिनव्यवहारविषयत्वेन सुबोधतया झटित्येव मनसि प्रविश्य प्रालेयहेतुविषयिणीं जिज्ञासां निवार्य तृप्तिं जनयति । इति दृष्टं प्रकृत्याग्रहस्य मनोवशीकरणक्षमत्वम् । वस्तुतस्तु । परीक्षया प्रालेयस्य हेतुरन्य एव सिद्धः । यदा यः पदार्थः स्वसमन्ताद्वर्तमानमार्द्रं वायुमपेक्ष्याधिकां शीततां भजते तदा तस्मिन् वायुगतो जलभागः सम्बध्यते स प्रालेयमित्युच्यते । यथा प्रयागादिदेशवर्तिनि यात्रिकलोकभद्राकरणभूमिपतितकेशोच्चये यावदधिकं प्रालेयं भवति न तावत् तत्परितोदेशे यद्याकाशादेव पतेत् तर्हि समन्ततोऽपि कस्मान्न पतेत् कस्माच्च निःश्वासा-

भिहते दर्पणेऽपि दिवा प्रालेयं भवेत् कस्माद्वाऽतिशिशिरवारि-
परिपूरितकाचपात्रबहिर्भागे प्रालेयं भवेत् कुतो वा वृष्टिसमये
द्वारघटितकाचफलकस्याभ्यन्तरपार्श्वे प्रालेयमुपलभ्येत नहि
तत्र तत्रोक्तोदाहरणे गगनपतितजलसम्बन्धस्य वा वृष्टिसम्बन्धस्य
वा सम्भवोऽस्ति किन्तु तेषां दर्पणादीनां समन्ताद्वर्तमानं वायुम-
पेक्ष्याधिकशीतलत्वान्निःश्वासादिवायुगतजलसम्बन्धः सम्भवद्-
क्तिकः स एव च प्रालेयहेतुरिति सिद्धम् । एतच्च निगमनं
परस्परासम्बद्धैः केशदर्पणकाचप्रभृतिभिरनेकैरुदाहरणैर्घटित-
मिति कृत्वा सम्यग्विचारं विना दुर्बोधं पूर्वगृहीतसिद्धान्तसंस्का-
रबलादत्यन्ताप्रामाणिकत्वेन च गृहीतमिति स्पष्टं प्रकृत्याग्रहस्य
यथोक्तस्वरूपत्वम् । प्रालेयोदाहरणानि सुबहूनि सन्ति तानि तु
व्याप्तिग्रहोपायविधिनिरूपणावसरे विस्तरेण निरूपयिष्यामः ॥

। २ । अथ मनुष्यजातिभिर्ज्ञातानां स्वरूपाभासानामीश्व-
रेण ज्ञातानां वस्तुस्वरूपाणां च परस्परं परमं वैलक्षण्यमस्तीति
पूर्वं प्रतिपादितं तत् स्पष्टीकर्तुं स्वरूपाभासानां सामान्यलक्षणं
तद्विभागं चाह ॥



मनस आवरणहेतवः स्वरूपाभासाश्चतुर्विधाः ।
जातिकृता गुहाकृताः पण्यवीथिकृता रङ्गभूमि-
कृताश्चेति ॥ १८ ॥

। १ । तत्र मनस आवरणहेतव इति सामान्यलक्षणम् । आवरणं नाम तत्त्वज्ञानप्रतिबन्धः । स्वरूपाभासा इति । स्वरूपवद् वास्तविकवस्तुधर्मवदाभासन्ते लोकैरभिमन्यन्ते मिथ्याज्ञानमात्रविषयीकृता अवास्तविका धर्मा इत्यर्थः । यथा जलस्याग्निस्त्रद्रव्यत्वं वायोर्गुरुत्वशून्यत्वमित्यादि ॥

। २ । तत्र जातिरिव जातिः सर्वमनुजसाधारणः स्वभावः । गुहेव गुहा तत्तत्पुरुषचित्तवृत्तिः । पण्यवीथिरिव पण्यवीथिर्लौकिकभाषाव्यवहारः । रङ्गभूमिरिव रङ्गभूमिः स्वस्वमतग्रन्थाः । तथाच जातिकृतत्वं नाम सर्वमनुजजातिसम्बन्धिना व्यतिरेकोदाहरणोपेक्षापूर्वकान्वयोदाहरणप्राबल्यकल्पनादिलक्षणेन साधारणेन स्वभावेन जनितं यन्मिथ्याज्ञानं तद्विषयत्वम् । यथा लोकाः फलज्यौतिषे स्वप्नेषु शकुनेषु च पक्षपान्वयोदाहरणदर्शनमात्रेण श्रद्दधते ॥

। ३ । गुहाकृतत्वं नाम तत्तन्मनुजव्यक्तिसम्बन्धिना प्रतिव्यक्तिविलक्षणेनासाधारणेन विशेषस्वभावादिदोषेण जनितं यन्मिथ्याज्ञानं तद्विषयत्वम् । यथा विद्यानां प्राचीनत्वमेव तत्त्वविषयतायां नियामकमित्याकारकदृढाग्रहवतां पुरुषाणां नवीनमतसामान्येऽसत्यत्वकल्पनम् ॥

। ४ । पण्यवीथिकृतत्वं नाम लोकव्यवहारसम्बन्धिना साधारणजनकल्पनामात्रव्यवस्थितशक्तिग्रहणेन परस्परवाङ्मिश्रणेन जनितं यन्मिथ्याज्ञानं तद्विषयत्वम् । यथा बौद्धाः शशविषाण-

कूर्मरोमबन्ध्यासुतखपुष्पमरीचिकातडागादीनां शब्दानां सत्त्वा-त् तदर्थानामपि सत्त्वं मन्यन्ते ॥

। ५ । रङ्गभूमिकृतत्वं नाम मतश्रद्धामात्रजन्यं यन्मिथ्या-ज्ञानं तद्विषयत्वम् । यथा बौद्धजैनयवनादयः स्वस्वमतग्रन्थप्र-तिपादितान् परमेश्वरानेकत्ववस्त्रपूतजलानिर्जन्तुत्वसप्तस्वर्गादी-न् सत्यत्वेन जानन्ति ॥

। ६ । एतेषां चतुर्णामुदाहरणान्तराणि विशेषनिरूपणानि भेदविचाराः परस्परवैलक्षण्यानि च विठ्ठलशास्त्रिकृते सटीके बेकनीयसूत्रानुवादे प्रपञ्चितत्वात् तत एवावगन्तव्यानीति नेह विचार्यन्ते ॥

। १ । अथेदानीं नियतसाहचर्यरूपाया व्याप्तेर्निश्चयो यैरु-पायैर्भवितुमर्हति तेषां विचारः कर्तव्यः । स च प्रकृतिप्रवाह-स्यैकरूपत्वे सिद्धे सम्भवति न त्वन्यथा । यदि वह्निः कदाचिद्द-हेत् कदाचिच्च शीतलयेत् जलं वा यद्वच्च शीतलयेत् क्वो दहेत् तर्हि नियतसाहचर्यान्वेषणं तदुपायविचारश्च निष्फल एव स्या-द्ततो नियतसाहचर्यज्ञानोपायविचारस्य सफलतां सूचयितुमाह

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प्रकृतिप्रवाह एकरूपः ॥ १९ ॥

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। १ । प्रकृतेर्जगतः प्रवाहः कार्यकारणधारात्मक एकरूपो नियतरूप इत्यर्थः ॥

। २ । ननु प्रकृतिप्रवाहस्यैकरूप्यं सार्वजनीनानुभवविरुद्धं न हि कश्चिदनुभूताननुभूतयोर्भूतभविष्यतोर्वा समानधर्मता-मध्यवस्यति । तथाहि न कश्चिदपि यादृशेनैव मासदिनप्रहरघटिकाच्चणादिक्रमेणैकस्मिन् वत्सरे दृष्टितद्भावौ व्यवस्थितौ तादृश एव तयोः क्रमः संवत्सरान्तरेऽपि भविष्यतीति मनुते । न वा यः स्वप्नोऽद्य रात्रावनुभूतः स एव श्वः परश्वो वा रात्रौ पुनः पुनरनुभविष्यत इति कश्चिदाशास्ते । प्रत्युत यदि कदाचित् पूर्वरात्रिदृष्टस्वप्नदर्शनं रात्र्यन्तरे भवेत् तर्हि लोकाश्चमत्कृतमनसो भवन्ति । तस्मात् कस्मिंश्चिद्दिने श्रेयःप्राप्तौ जातायां तज्जातीयदिनान्तरेऽपि श्रेयःप्राप्तिविषयिणी पामरजनानां प्रत्याशेव प्रकृतिप्रवाहेऽपि नियमसादृश्ययोः सम्भावना निर्मूलत्वाद् दृथैव । न च युक्त्याऽपि प्रकृतिप्रवाहस्यैकरूप्यं सिध्यति । व्यभिचारोपलम्भेनाव्यवस्थितत्वात् । तथाहि केचिद्धर्मा यथैकवारमुपलब्धास्तथैव सर्वत्र दृश्यन्ते यथा वह्निधूमौ । केचित्त्वत्यन्तमव्यवस्थिताश्चिन्तिता अपि नोपतिष्ठन्ते अचिन्तिता अप्युपलभ्यन्ते यथा रात्रिविशेषस्वप्नविशेषौ । अन्येतु दृढनिश्चितनियतसाहचर्या अपि पूर्वगृहीतं स्वसहचरं धर्मं विहायान्येनैव केनचिदसम्भावितेनादृष्टपूर्वेण धर्मेण सामानाधिकरण्यं भजन्त उपलभ्यन्ते यथा हंसत्वशुक्लरूपवत्त्वे । तयोर्हि सामानाधिकरण्यं नियतमिति सर्वैः पुरातनैर्जनैः स्वीकृतं यदा पुनर्दक्षिणमहाद्वीपे कृष्णवर्णा हंसा उपलब्धास्तदा व्यभिचारदर्शना-

द्विरादेव परित्यक्तमिति चिरपरिचितेऽपि साहचर्यनियमे वि-श्वासाभावात् प्रकृतिप्रवाहस्यैकरूपत्वं न स्वीकर्तुमर्हमिति चेत् सत्यमेतत् परन्तु सर्वेषामेव धर्माणां सर्वैर्धर्मैः सह साहचर्यनि-यमोऽस्तीति वयमपि न ब्रूमः अपितु कैश्चिदेव केषाञ्चिद्येषां तु यैर्धर्मैः सह नियतं साहचर्यं वर्तते तत्रत्यस्य साहचर्यनियम-स्यान्वेषणे त्ववश्यं यतितव्यम् ॥

। ३ । एवं सिद्धे साहचर्यनियमान्वेषणोपायविचारस्याव-श्यकत्वे य उपायः साधारणजनैरङ्गीकृतस्तावन्मात्रेण न सम्पूर्ण-फलनिर्वाहः । तथाहि साधारणजना अन्वयुदाहरणभूयोद-र्शनमात्रादेव सहसा साहचर्यनियमं कल्पयन्ति न तु व्यभिचारं सम्भाव्य व्यतिरेक्युदाहरणान्यप्यन्वेषयन्ति तथाच सत्यन्वेषणा-भावाद् व्यभिचारदर्शनाभावे स्वकल्पनां सत्यां मन्यमानाः क्वचित् स्थले दृष्टमपि व्यभिचारं विविधोपाधिकल्पनया दूरीकर्तुमीह-न्ते । वक्ष्यमाणसमीचीनव्याप्तिग्रहोपायविदस्तु यथा व्यतिरेक्यु-दाहरणपरीक्षां कृत्वा व्यभिचारं स्थापयन्ति व्यभिचारशङ्कां वा वारयन्ति तं प्रकारं वक्ष्यामः ॥

। ४ । ननु किं तर्हि साधारणजनैर्व्यवहृतमन्वयोदाहरण-दर्शनं निष्फलमेवेत्याशङ्कां निराकर्तुमाह ॥

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अन्वयोदाहरणान्यधिकृत्य व्याप्त्यन्वेषणमा-रभ्यते ॥ २० ॥

। १ । अयं भावः । अन्वयोदाहरणादर्शने व्याप्त्यन्वेषणस्यारम्भमात्रं न तु तत्र समाप्तिः । समाप्त्यर्थं तु सुनिश्चितोऽत्यन्तसमर्थ उपायोऽवश्यमपेक्षितस्तस्यैव हि विचारणमेतस्य प्रकरणस्य विषय इति ॥

। २ । अथ प्रकृतिप्रवाह एकरूप इत्यस्यार्थं स्पष्टीकर्तुमाह ॥

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तत्तद्धर्मसाहचर्यनियमविशिष्टधर्मान्तरसमुदाय-
रूपत्वमेव प्रकृतिप्रवाहस्यैकरूपत्वम् ॥ २१ ॥

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। १ । अयंभावः । न तावत् प्रकृतिप्रवाहो नाम कश्चित् स्वतन्त्रः पदार्थोऽपितु परस्परव्याप्यव्यापकभावापन्नानां धर्माणां निःशेषसमुदाय एव । तत्तद्धर्माणां साहचर्यनियमस्तु प्रसिद्ध एकस्यान्वये ऽपरस्यान्वयात् एकस्य व्यतिरेकेऽपरस्य व्यतिरेकात् । तैरेतैः प्रत्येकं तत्तद्धर्मसाहचर्यनियमविशिष्टैर्धर्मान्तरैस्तन्तुभिरिवावयवभूतैः प्रकृतिप्रवाहसंज्ञकोऽयं प्रपञ्चः पट इव महानवयवी घटितोऽस्तीति प्रत्येकं नियतत्वात्मकस्यैकरूपत्वस्य दर्शनात् समुदायोऽप्येकरूप इत्युच्यते ॥

। २ । अथ साहचर्यनियमानां भेदानाह ॥

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समीचीनेन व्याप्तिग्रहोपायेनान्विष्य निर्णीताः
कतिपये नियमा नियमबीजानीत्युच्यन्ते ॥ २२ ॥

। १ । तथाहि यो नियमो नियमान्तरफलरूपो न भवति यस्माच्च नियमान्तरमुत्पद्यते स नियमबीजत्वेन व्यवहर्तव्यः । यथा । वायुर्गुरुरिति निष्पीडनं द्रवपदार्थे सर्वदिगभिमुखं गमनं जनयतीति प्रतीपबलेनाप्रतिरुद्धं बलं गतेर्हेतुरित्यादि । अतएव यो नियम उक्तविधनियमजन्यत्वान्नियमान्तरफलरूपो भवति स नियमफलत्वेन व्यवहर्तव्यः । यथा । ताराचलाख्येन प्रकाशितं काचनाले पारदोद्गमनम् । तद्धि पूर्वोदाहृतनियमद्वयस्य फलं चारितार्थ्योदाहरणस्थलं तद्विज्ञानेन विज्ञेयं चेति । काचनाले पारदोद्गमनप्रकारस्तु वायुगुरुत्वप्रकरणे स्पष्टः ॥

। २ । अथ नियमविशेषाणां नियमबीजत्वव्यवहारे हेतुमाह ॥

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ये नियमा जगदीश्वरेच्छाविषयास्त एव नियमबीजानि भवन्ति ॥ २३ ॥

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। १ । तथाहि जगन्नियामकतया सर्वज्ञः सर्वशक्तिरप्रमत्तःस्वतन्त्रो जगदीश्वरः सिध्यति येषां च नियमानां तदीयेच्छाविषयत्वस्वीकारे जगदन्तर्गतानां सर्वेषां नियमान्तराणां निर्वाहो ज्ञानं च भवितुमर्हति तन्नियममात्रविषयिणी तस्येच्छाऽपि सिध्यति कल्पनालाघवात् न तु सर्वविषयिणी गौरवात् प्रयोजनाभावात् प्रमाणाभावाच्चेति ॥

। २ । ननु वक्ष्यमाणव्याप्तिग्रहोपाय एव यदि व्याप्तिज्ञाने

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हेतुस्तर्हि लोके धूमवह्न्यादेर्व्याप्तिर्न ज्ञायेत । न हि लोकैर्भवदभिप्रेत उपायो ज्ञातोऽस्ति यदि च लोके व्याप्तिनिश्चायकोऽन्य एव कश्चिदुपायोऽस्तीत्युच्यते तर्हि तेनैव सर्वत्र कार्यसम्भवे किमर्थमभिनवो व्याप्तिग्रहोपायो निरूपणीय इत्याशङ्कां निराकरोति ॥

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स्वयमुपस्थितवस्तुसम्बन्धिनीः स्वभावेन ज्ञाता
व्याप्तीर्दृष्टान्तत्वेनादायाभिनवस्थले व्याप्त्यन्वेषणार्थं शास्त्रेषूपाया उपदिश्यन्ते ॥ २४ ॥

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। १ । स्वयमुपस्थितेत्यादि । न हि यदन्नं तत् पुष्टिहेतुर्यज्जलं तन्मज्जनतृषोपशमनहेतुर्यः सूर्यः स प्रकाशतापहेतुः पाषाणादि च पतनशीलमित्यादिव्याप्तीनां ज्ञाने शास्त्रस्य स्वल्पाऽप्यपेक्षाऽस्ति अन्नजलसूर्यादीनां स्वयमुपस्थितत्वेन क्षुत्तृट्शीतादीनां च स्वभावायातत्वेन तत्रत्यव्याप्तीनामाबालमापण्डितमनायासेनैव निश्चितत्वात् । ये तु पदार्थाः स्वयं नोपतिष्ठन्ते उपस्थिता अपि वा व्याप्यव्यापकभावेन स्वभावतो निश्चेतुं न शक्यन्ते तत्रत्यव्याप्तिनिश्चयरूपमहाफलसिद्धये व्याप्त्यन्वेषणोपायानुपदेष्टुं शास्त्रं प्रवर्तते । यदि च लोके काचनापि व्याप्तिः केनापि कदापि न निश्चीयेत तर्हि शास्त्रमपि तदन्वेषणोपायोपदेशे कथं प्रवर्तेत अश्रुतादृष्टविषयरूपाणां शास्त्रीयसिद्धान्तानां

ज्ञानस्य सर्वजनसम्मतविषयरूपदृष्टान्तज्ञानमूलकत्वात् ॥

। २ । अथात्र कार्यकारणभावमूलकव्याप्तेरन्वेषणस्योपाया नामभिधानं कार्यकारणभावस्वरूपनिरूपणमपेक्षते इति कार्यकारणभावस्वरूपं निरूपयितुमाह ॥

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यस्य यस्यारम्भो भवति तस्य कारणमस्ति ॥ २५ ॥

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। १ । कारणमस्तीति । कारणं नाम यस्य सत्त्वेऽव्यवहितोत्तरक्षणे कार्यं जायत एव तत् । तथाच परस्परसहकारिपदार्थसमुदायरूपा सामग्र्येवकारणशब्देन शास्त्रेषु व्यवहर्तव्या न तु लोकवत् तद्घटकाः पदार्थाः प्रत्येकमपि । एकैकमात्रसत्त्वे कार्यानुत्पादात् । लोके तु क्रमेण सङ्गीभवतां पदार्थानां मध्ये यस्यागमनं चरमत्वेन कार्याव्यवहितपूर्ववृत्तित्वेन ज्ञायते तस्मिन् कारणत्वं व्यवह्रियते । चरमत्वस्य तु कालदेशभेदेन सर्वेषु सामग्र्येकदेशेषु सम्भवात् सर्वत्र कारणत्वव्यवहारो लोकानां युक्तः । यथा जले प्रक्षिप्तः पाषाणस्तलं गच्छतीत्यत्र पाषाणस्य तलगमने कारणभूता या सामग्री तद्घटका बहवः पदार्थाः सन्ति । तथाहि । पाषाणो जलं जलप्रक्षेपस्तलप्रदेशः क्षित्याकर्षणं पाषाणनिष्ठं क्षित्याकर्षणविषयत्वं जले निमग्नस्य पाषाणस्य स्वावरणभूतजलभागगतगुरुत्वाधिकगुरुत्वं चेति । शास्त्रे त्वेतेषां समुदायः कारणमितिव्यवहारः समुचितः यदि तु

लोके पृच्छ्यते पाषाणस्य तलप्राप्तौ किं कारणमिति तर्हि कश्चित् जनः पूर्वोक्तपदार्थानां मध्ये प्रथममेव कारणं वक्ष्यति कश्चित् द्वितीयं कश्चित् तृतीयमिति तत्र तु नास्माभिः कोऽपि दोष उच्यतेऽपितु लाघवार्थं शास्त्रे सामग्र्येव कारणत्वेन व्यवह्रियते । प्रतिबन्धकाभावोऽपि तस्यामेवान्तर्भवति न तु तस्य पृथक् कारणत्वमिति ॥

। २ । ननु यत्र पदार्थद्वयस्य पूर्वोत्तरवृत्तित्वं न लक्ष्यते तत्र कार्यकारणभावनिश्चयो न भवितुमर्हति । यथा । घटस्य तदीयरूपरसादीनां क्रमो न लक्ष्यत इति तत्र कार्यकारणभावसन्देहः । यदि च यौगपद्येऽपि घटः कारणं रूपादिकं च कार्यं तर्हि रूपादिकं कारणं घटः कार्यमिति वैपरीत्यं कुतो न स्यात् इति शङ्कामभ्युपगमेन समाधत्ते ॥

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क्रमस्थले कारणत्वनिश्चायकं पूर्वत्वं न हि कार्यस्यापि कदाचित् कारणात् पूर्वत्वं सम्भवति यौगपद्यस्थले तु सम्प्रति सन्देहोऽस्तु ॥ २६ ॥

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। १ । सम्प्रतीति । यौगपद्यस्थले कार्यकारणभावनिर्णायिका युक्तिर्नेदानीं प्रदर्श्यते किन्त्वग्रे प्रदर्शयिष्यते तेनेदानीं तद्विषये सन्देहसत्त्वेऽपि न दोष इति भावः ॥

। २ । ननु यदि क्रमस्थले पूर्वापरीभावः कार्यकारणभा-

वनिश्चायकस्तर्हि पूर्वक्षणवर्तिनः पदार्थसमुदायस्योत्तरक्षणवर्ति-पदार्थसमूहं प्रति कारणत्वनिर्णयेऽपि तत्समुदायनिविष्टानां पदार्थानां विशेषकार्यकारणभावः कथं निश्चेय इत्याकाङ्क्षायां विशेषकार्यकारणभावनिर्णयप्रकारमाह ॥

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विचारारम्भे पूर्ववृत्तित्वेनोत्तरवृत्तित्वेन चोपस्थितः पदार्थसमूहो विवेचनीयः ॥ २७ ॥

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। १ । विवेचनीय इति । के के पदार्थास्तद्घटकाः सन्तीति सर्वे तदेकदेशा विशेषरूपेण ज्ञातव्या इत्यर्थः ॥

। २ । ननु किं तत्समुदायद्वयैकदेशानां विशेषधर्मविचारमात्रेण प्रकृतोऽर्थः सिध्यतीति चेन्नेत्याह ॥

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तदेकदेशानामपसरणन्तु निर्णयस्य मूलम् ॥ २८ ॥

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। १ । अपसरणमिति । असमवधानमित्यर्थः । तथाहि यदि तावत् कुलालकपालचक्रदण्डचीवरादीनि कुविन्दतन्तुतुरीवेमादीनि आर्द्रेन्धनवह्नितदुभयसंयोगादीनि बीजवारिधरणितेजःपवनादीनि पूर्वक्षण उपलभ्य घटपटधूमाङ्कुरादीन्युत्तरक्षणे कश्चित् पश्यति ततश्च पूर्वसमुदायादयमुत्तरसमुदाय उत्पन्न इति जातनिश्चयोऽपि घटपटादेर्विशेषकारणविषये सन्दिहानो भवति । तर्हि तेन निर्णयार्थं विचारमारभमाणेनादौ कति

पदार्थाः पूर्वमुपलब्धाः कति चोत्तरमिति विचार्य तेषां परिगणनं कर्तव्यम् । ततोऽनन्तरमेकं घटादिकं कार्यं कर्तव्यत्वेनादाय पूर्ववृत्तित्वेन गृहीतात् समुदायादेकैकं निष्काशनीयं । तत्र यदि तन्तुबीजवह्न्यादिषु निष्काशितेषु घटस्योत्पत्तिरुपलभ्यते तर्हि तानि घटस्य न कारणानीति निर्णीयत इति ॥

। २ । तदिदमपसरणं द्विविधं मनुष्येच्छाधीनमीश्वरेच्छाधीनं चेति । तत्र मनुष्येच्छाधीनमपसरणं पुरुषेण स्वयं यतित्वा परीक्षणीयं यथोदाहृतस्थले । ईश्वरेच्छाधीनं पुनः प्रतीक्षणीयं यदा जायेत तदा द्रष्टव्यं यथा ग्रहणादिविषये । यदि तत्र सोमवासरादिदिनविशेषस्य पूर्ववृत्तित्वं दृष्ट्वा कारणत्वसन्देहो जायते तर्हि सोमवासरापसरणस्य सोमवासरमपसार्य ग्रहणाद्युत्पादनस्य चेश्वरेच्छाधीनत्वाद्यदा सोमवासरं विहाय ग्रहणमुत्पद्येत तदा द्रष्टव्यं । प्रतीक्षापरीक्षयोः स्वरूपं पूर्वमेव निरूपितम् । अथ प्रतीक्षास्थले परीक्षास्थले च दिदृक्षितत्तत्कार्यदर्शनं समानम् । इयांस्तु विशेषो यत् प्रतीक्षास्थलीयकार्यदर्शने पुरुषो न स्वतन्त्रः परीक्षास्थले तु स्वतन्त्र इति ॥

। ३ । अथ प्रतीक्षापरीक्षयोः प्रत्येकमन्वयव्यतिरेकस्थलविषयकत्वेनद्वैविध्यमाह ॥

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पूर्ववर्तिपदार्थसमुदाये उत्तरवर्तिपदार्थसमुदाये
च तत्तत्पदार्थेन सह नियतसाहचर्यरूपसम्ब-

न्धविशिष्टस्य पदार्थान्तरस्य निर्धारणे कर्तव्ये तत्र प्रथममन्वयस्थलविवेचनं व्यतिरेकस्थलविवेचनं चोपायः ॥ २९ ॥

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। १ । अथानयोरुपाययोर्व्याप्तिग्रहसम्पादनरूपे कार्ये विनियोगो यन्नियमानुसारेण कर्त्तव्यस्तान्नियमानाह ॥

। २ । अथ प्रथमो नियमः ॥

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जिज्ञासितकारणकस्य धर्मस्य सर्वाण्यन्वयस्थलानि केवलं येनासाधारणधर्मेण सदृशानि स तस्य हेतुर्भवतीति ॥ ३० ॥

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। १ । यथा । सर्वाणि धूमवन्ति स्थलानि केवलमार्द्रेन्धनसंयुक्तवह्निमत्त्वेनासाधारणधर्मेण सदृशानीत्यार्द्रेन्धनसंयुक्तवह्निर्धूमस्य हेतुरिति ॥

। २ । अथ द्वितीयो नियमः ॥

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प्रकृतधर्मस्यान्वयव्यतिरेकोदाहरणे यद्धर्मातिरिक्तसर्वधर्मैः सदृशे सोऽन्वयोदाहरणनिष्ठो धर्मः प्रकृतधर्मस्य कारणं भवतीति ॥ ३१ ॥

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। ३ । यथा धूमवन्ति धूमाभाववन्ति च पर्वतमहानसचत्व-

रगोष्ठानि परस्परमार्द्रेन्धनसंयुक्तवह्निमत्वातिरिक्तैः पर्वतत्वमहानसत्वचत्वरत्वगोष्ठत्वादिभिर्धर्मैः सदृशानि भवन्ति ततः स आर्द्रेन्धनसंयुक्तवह्निमत्त्वरूपो धूमवन्निष्ठो धर्मो धूमस्य हेतुरिति ॥

। ४ । अथ तृतीयो नियमः ॥

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यदा यदैकस्य धर्मस्य तारतम्यं भवति तदा तदा चेदन्यस्यापि तदनुसारेण तारतम्यं भवेत् तर्हि तयोः कार्यकारणभावो ज्ञेय इति ॥ ३२ ॥

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। १ । यथा चन्द्रसान्निध्यतारतम्यात् समुद्रवृद्धितारतम्यं भवतीति चन्द्रसान्निध्यं समुद्रवृद्धेर्हेतुरिति ॥

। २ । अथैतेषां नियमानां कार्ये विनियोगः प्रदर्शनीयः । तदर्थं सप्तदशसूत्रव्याख्याने सिद्धवन्निर्दिष्टस्य प्रालेयस्वरूपस्य तत्कारणस्य च जिज्ञासामधिकृत्य तद्विनियोगः प्रदर्श्यते तत्र तावत् जिज्ञासितविषयस्य कारणाद्यन्वेषणात् पूर्वं तद्वाचकपदस्य प्रवृत्तिनिमित्तं निश्चेतव्यमतः प्रालेयत्वं वृष्टिकुज्झटिकादिभ्यो व्यावृत्तं सर्वतत्पदाभिधेयसाधारणं निर्वचनीयं तच्चावर्तमानवृष्टिप्रभृतिकानावृतस्थलवृत्तिपदार्थेषु स्वतन्त्रप्रतीयमानजलविशेषत्वम् । एवं जिज्ञासाविषये व्यवस्थापिते प्रथमनियमानुसार्यन्वेषणं कर्तव्यमिति विंशत्तमसूत्रानुसारेणाह ॥

यदा कस्यचिद् धर्मस्य कारणं जिज्ञासितं तदा पर-
स्परमत्यन्तविलक्षणान्यपि तदन्वयोदाहरणानि
सर्वाणि प्रथमं परिगणनीयानीति ॥ ३३ ॥

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। १ । तदन्वयोदाहरणानीति । प्रालेयं तावन्निःश्वासाभिहतेष्वनुष्णेषु धातुपाषाणादिषु दृश्यते ग्रीष्मे कूपात् प्रत्यग्रोद्धृतजलेन पूर्यमाणस्य काचचषकस्य बहिर्भागे दृश्यते दृष्ट्या करकापातेन वा बाह्यवायौ जडीभूते सति द्वारघटितकाचाभ्यन्तरपार्श्वे दृश्यते इत्यादीनि सर्वाणि प्रालेयवन्ति स्थलानि स्वसंयुक्तवायुगतशीतताधिकशीततारूपेण धर्मेण सदृशानि नियतं भवन्ति । ननु नैशप्रालेये व्यभिचारः नहि तत्र प्रालेयवतां पदार्थानां स्वसंयुक्तवाय्वधिकशीतताजनकं किमपि सम्भाव्यत इति चेत् । जनकं किमित्यन्यदेतत् । तथापि नैशप्रालेयवतां पदार्थानां वाय्वधिकशीतत्वे परीक्षा प्रमाणमस्ति । सा च सुघटा । तथाहि प्रालेयवति पदार्थे एकमुष्णतामापकयन्त्रं संयोज्य किञ्चित्तदुपरिवायावपरं विलम्बयेदित्येवंविधा परीक्षा जिज्ञासुभिर्बहुधा कृतोक्तविधो धर्मश्च नियमेनोपलब्ध इति प्रालेयस्य परितोवाय्वधिकशीतत्वस्य च नियतसाहचर्यं सिद्धम् ॥

। २ । अथ नियतसाहचर्यसिद्धावपि किं प्रालेयस्य तादृशशीतत्वं कारणमुत प्रालेयं तादृशशीतत्वस्याथवा तदुभयमपि कारणान्तरप्रयोज्यमिति सन्देहोऽवशिष्यते तन्निवृत्तिश्च नान्व-

योदाहरणसहस्रदर्शनेनापि सम्भवतीति तत्समर्थमुपायान्तर-मनुसरणीयम् । प्रकृत्याग्रहपक्षपातिनस्तु यदा यदा प्रालेयं तदा तदा शैत्यस्यानुभवाच्छैत्यं प्रालेयस्य कार्यमिति वदन्ति तत्र समर्थहेतोरदर्शनेन प्रामाण्यसन्देहे प्रकृत्यध्ययनपरैर्जिज्ञासुभिः प्रकृतविषये तत्त्वनिर्णयो येनोपायेन कर्तव्यस्तं व्यतिरेकस्थलप-रीक्षारूपं चतुर्विंशतितमसूत्रोक्तद्वितीयनियमानुसारेणाह ॥

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तथा व्यतिरेकोदाहरणानि परिगणनीयानि किञ्च प्रकृतधर्मव्यतिरेकस्तेषु स्थलेषु विशेषेणान्वेषणीयो यान्यन्वयोदाहरणैः सुसदृशानि स्युरिति ॥ ३४ ॥

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। १ । स्पष्टम् । सुसदृशानीति । अनावृतवायौ स्थितेषु सुस्निग्धपृष्ठेषु धातुखण्डेषु प्रालेयं न जायते जायते च तत् तादृशेष्वेव प्रभूतं काचेषु । कदाचिच्च तिर्यगवस्थितकाचफल-कस्याधः पार्श्वेऽपि जायते किन्त्वेतेऽन्वयव्यतिरेकोदाहरणे न सुसदृशे धातुकाचयोर्बहुभिर्धर्मैर्भेदात् । धातुस्तावद् घनाघातेन पत्रीकरणयोग्योऽपारदर्शकोऽधिकगुरुत्वश्च काचस्तु न तथा काचस्तु भङ्गुरः पारदर्शको न्यूनगुरुत्वश्च धातुस्तु न तथेति । अत्र च न द्वितीयनियमविनियोगः एकेनैव धर्मेण परस्परवि-लक्षणयोरन्वयव्यतिरेकोदाहरणयोस्तद्विनियोगविषयत्वात् । एतावत् पुनरत्रापि ज्ञातुं शक्यते यद् यैर्यैर्धर्मैर्व्यतिरेकोदाहर-

णादन्वयोदाहरणं भिद्यत तद्धर्मसमूहमध्ये प्रकृतधर्मस्य कारणमस्तीति ॥

। २ । परन्तु यदि प्रालेयवतां बहूनां पदार्थानां काचस्य चैक एव साधारणधर्मो विद्यते यः प्रालेयाभाववत्सु द्रव्यान्तरेषु धातौ च नास्तीति निश्चीयेत तदा द्वितीयनियमस्य फलं सिद्धम् । अतश्च स धर्मः प्रालेयस्य हेतुर्भवतीति सेत्स्यति । अधिकान्वेषणेऽप्येषैव दिगनुसर्तव्या ॥

। ३ । एवञ्च सुस्निग्धपृष्ठयोः काचधात्वोः प्रालेयभावाभावदर्शनात् प्रालेयप्रयोजकं न स्निग्धपृष्ठत्वं किन्तु द्रव्यजातिविशेष इति स्पष्टं प्रतीयतेऽतः स्निग्धपृष्ठानि नानाजातीयकानि द्रव्याणि बाह्यवायौ निधेयानि तथा कृते च प्रालेयोत्पत्तेः काचित् तारतम्यश्रेण्युपलभ्यते तथाहि स्निग्धपृष्ठानां पदार्थानां यथा यथोष्णतासञ्चारकत्वं न्यूनं तथा तथा प्रालेयोत्पत्तिमत्त्वमधिकं यथा यथाचोष्णतासञ्चारकत्वमधिकं तथ तथा प्रालेयवत्त्वं न्यूनमिति अस्मिंश्च तारतम्यरूपे विषये न द्वितीयनियमस्य विनियोगः सर्वेषामेव पदार्थानां यथायथमुष्णतासञ्चारकतया तदभावस्यालभ्यत्वात् अतोऽत्र तृतीयनियमस्य विनियोगः कर्तव्य इत्यभिप्रेत्य पञ्चविंशतितमसूत्रानुसारेणाह ॥

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यस्यामेकस्यां बह्वीषु वा यासु व्यक्तिषु प्रकृतजिज्ञासाविषयो धर्मो न्यूनोऽधिको वोपलभ्यते तादृ-

श्यो व्यक्तयः परिगणनीयाः । यतः कार्यस्य कारणे काश्रिततया प्रकृतकार्यस्य न्यूनत्वाधिकत्वानुसारिणी यस्य न्यूनत्वाधिकत्वे नोपलभ्येते स न कारणमिति सिध्यतीति ॥ ३५ ॥

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। १ । इति सिध्यतीति । तथाच प्रकृते सर्वधर्मैः साद्दश्येऽपि यस्यां व्यक्तावुष्णतासञ्चारप्रतिबन्धकशक्तिर्यावती विद्यते तावांस्तत्र प्रालेयसम्बन्धोऽतः प्रालेयसम्बन्धोत्पत्त्यनुकूलत्वात् तस्याः शक्तेः प्रालेयप्रयोजकत्वं सिद्धम् ॥

। २ । अथ यदि बन्धुरपृष्ठाः पदार्था बाह्यवायौ निधीयन्ते तर्ह्युक्तनियमो व्यभिचरतीत्युपलभ्यते तथाहि बन्धुरपृष्ठे लोहखण्डे विशेषेण रङ्गलिप्ते शीघ्रं प्रालेयं जायतेऽतस्तथाविधपृष्ठस्य प्रालेयानुकूलत्वं दृश्यते ॥

। ३ । अत्र च यदि द्वितीयनियमानुसारेण भिन्नाकारपृष्ठा लोहजातीयाः पदार्था बाह्यवायौ निधीयन्ते तर्ह्यन्या काचन तारतम्यश्रेण्युपलभ्यते तथाहि स्वस्मात् किरणरूपेण निर्गच्छन्त्योष्णतया यथा यथा यत् पृष्ठं वियुज्यते तथा तथा तस्य प्रालेयसम्बन्धोऽधिको भवतीति इहापि तारतम्यविषये द्वितीयनियमविनियोगो न सम्भवति सर्वपदार्थानामुष्णताकिरणकारकत्वेन तद्व्यतिरेकस्यालभ्यत्वात् किन्तु तत्र तारतम्यविषयकतृतीयनियमसञ्चारः कर्तव्यस्तेन चेदं सिध्यति यद् येषां पदार्था-

नामुष्णताकिरणीकरणानुकूला यावती शक्तिस्तावांस्तत्र प्रालेयसम्बन्धोऽत उष्णतासञ्चारप्रतिबन्धकशक्तिविशेषवत् स्वातन्त्र्येणोष्णताकिरणीकरणानुकूलशक्तेरपि प्रालेयप्रयोजकत्वं सिद्धम् ॥

। ४ । अथ यथा जातिविशेषस्य पृष्ठविशेषस्य च प्रालेयप्रयोजकत्वं तथा संस्थानविशेषस्यापि स्यादिति सम्भाव्यते तत्र चोक्तप्रकारकपरीक्षायां प्रयोगे तृतीया तारतम्यश्रेण्याऽऽविर्भवति यया पाषाणधात्वादीनामशिथिलसंस्थानानां प्रालेयाननुकूलत्वं शिथिलसंस्थानानां च तूलोर्णाप्रभृतीनां प्रचुरप्रालेयोत्पत्त्यनुकूलत्वं सिध्यति परन्त्विहापि सर्वपदार्थसंस्थानानां यथायथं शिथिलसंस्थानतया तद्व्यतिरेकस्यालभ्यत्वेन द्वितीयनियमविनियोगाभावात् तृतीयनियमविनियोगेनेदं सिध्यति यदुष्णतासञ्चारप्रतिबन्धकशक्तिवदुष्णताकिरणीकरणानुकूलशक्तिवच्च संस्थानशैथिल्यमपि स्वातन्त्र्येण प्रायलेप्रयोजकमिति ॥

। ५ । सोऽयं संस्थानशैथिल्यात्मकः प्रालेयहेतुः पूर्वोक्तादुष्णतासञ्चारप्रतिबन्धकशक्तिलक्षणात् तद्धेतोर्नातिरिच्यते । यतः शिथिलावयवा एव पदार्था विशेषेण परिधानार्थमाद्रियन्ते ते ह्यन्तः सोष्माणो बहिरत्यन्तशीतलाः सन्तः शरीरान्तर्वर्तिन्या उष्णताया बाह्यवायौ सञ्चारं वारयन्ति । तथाचैतत् तृतीयं साहचर्यं प्रथमसाहचर्यस्य दार्ढ्यायोपयुज्यते । इत्थञ्च यत्र यत्र प्रालेयं तत्र तत्रोष्णताकिरणीकरणानुकूलशक्तितत्सञ्चारप्रतिबन्धकशक्त्योरन्यतरदस्तीति प्रतीयते यस्य माहात्म्यात् प-

दार्थाः स्वस्मिन् परनिष्ठोष्णतासञ्चारे यावच्छैत्यं तदधिकशैत्येन स्वान्तर्गतामुष्णतां परित्यजन्ति । यत्र यत्र च न प्रालेयं तत्र नोक्तान्यतरशक्तिरिति ॥

। ६ । अथ यदि प्रालेयान्वयोदाहरणानि तदीयव्यतिरेकोदाहरणेभ्यः स्वस्मिन् परनिष्ठोष्णतासञ्चारे यावच्छैत्यं तदधिकशैत्येन स्वनिष्ठोष्णतापरित्यागशीलत्वादन्येन केनापि धर्मेण न भिद्यन्ते इति निश्चीयते तर्हि प्रक्रान्ता प्रालेयहेतुजिज्ञासा निवृत्ता स्यादिति सम्भाव्यते ॥

। ७ । अत्र यद्यप्यसर्वज्ञेन प्रालेयहेतुविषयकसम्पूर्णतत्त्वनिश्चयो न प्राप्तुं शक्यते इति कश्चिददृष्टाश्रुतपूर्वोऽन्यो धर्मः प्रालेयान्वयव्यतिरेकानुविधायी संसारे स्यात् तथापि स धर्म उष्णतासञ्चाराधिकतद्वयशीलत्वस्याप्यन्वयव्यतिरेकानुविधायी स्यादेवेति वक्तुं शक्यते एवञ्चोष्णतासञ्चाराधिकतद्वयशीलत्वं प्रालेयकारणं माभूत् तथापि तत्कारणस्य नियतसहचारि भवत्येवातस्तस्यैव कारणत्वेन व्यवहारेऽपि न काचित् क्षतिरित्यलं प्रासङ्गिकेन प्रकृतमनुसरामः ॥

। ८ । यत्र यत्र प्रालेयं तत्र तत्र स्वसंयुक्तवायुगतशीतताधिकशीतत्वमिति पूर्वं निर्णीतम् अयन्तु सन्देहः किं तादृक् शीतत्वं प्रालेयस्य कार्यमुतवा कारणमिति तत्र साधारणलोकव्यवहारात् कार्यमिति प्राप्तेऽभिधीयते प्रालेयस्य हेतुस्तादृक् शीतत्वं तस्य च हेतुरुष्णतासञ्चाराधिकतद्वयशीलत्वं निशि बाह्यवायु-

स्थानां पदार्थानां हि स्वाभाविकेनैवोष्णतासञ्चाराधिकतद्व्यय-शीलत्वेन तादृशी शीतता जन्यते तस्या यदि प्रालेयं कारणमुच्यते तर्हि प्रालेयेन तादृशी शीतता सर्वत्र किमिति न जन्यते किमिति वा तेष्वेव पदार्थेषु जन्यते यत्नेयं प्रदर्शितेन स्वभावसिद्धेन तद्व्यक्तिधर्मेण हेतुना प्राप्नोति । तथाच प्रालेयं तादृशशीतत्वस्य कारणमिति न किञ्चिदेतत ॥

। ९ । ये तु त्रयो विकल्पाः पूर्वमुक्ताः किं प्रालेयं तादृशशीतत्वस्य हेतुरुत तदुभयस्य तृतीयः कश्चित् कारणमथवा तच्छीतत्वं प्रालेयस्य कारणमिति तत्र प्रथमो निरस्तः द्वितीयस्तु न सम्भवति उक्तस्य तादृक्शीततकारणस्य सिद्धत्वात् सम्भवति दृष्टे हेतावदृष्टकल्पनाया अन्याय्यत्वात् तस्मात् तादृक्शीतत्वं प्रालेयस्य कारणमिति तृतीयः पक्षः परिशेषात् प्रामाणिक इति स्वीक्रियत इति ॥

। १० । एवं नवीनतत्त्वनिश्चयसम्पादनेऽवश्यापेक्षणीयेषु नानाविधेषूदाहरणेषु नियमविशेषाणां विनियोग उक्तस्तत्रेदं विचार्यते किं सर्वेषामुदाहरणानां तत्त्वनिश्चयार्थमुपादेयत्वं समानमथवा न्यूनाधिकं येन कस्यचिदुदाहरणगणे प्रथमं परिगणनं कस्यचिच्च ततः परमिति तत्रोत्तरपक्षस्वीकारेणाह ॥

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उदाहरणानामुपादेयत्व परमस्तरतमभावो वर्तत इति ॥ ३६ ॥

। १ । तथाहि अन्विष्यमाणाः पदार्थाः क्वचिदुदाहरणा उत्कर्षेण क्वचिदपकर्षेण क्वचिच्छुद्धरूपेण क्वचिच्च मिश्ररूपेणोपलभ्यते तेषां परस्परवैलक्षण्यविचारे बेकनेन सप्तविंशतिप्रकारा उपादेया उक्ताः तद्विस्तरस्तु विठ्ठलशास्त्रिकृते बेकनीयानुवादे द्रष्टव्यः । अतोऽव ये उपादयेषूपादेयतरास्ते उदाहरणभेदा निरूप्यन्ते ॥

। २ । यान्युदाहरणानि जिज्ञासितधर्मातिरिक्तधर्मैः परस्परं साधर्म्यरहितानि वैधर्म्यरहितानि वा तानि कैवल्योदाहरणानीत्युच्यन्ते तेषां दर्शनेनान्वेषणस्य विषयनियम इतरव्यावृत्तिरूपः शीघ्रं भवति । तथाहि रूपस्य को हेतुरिति जिज्ञासाया उपक्रमे स्फटिकविपार्श्वकाचदण्डजलबिन्द्वादयः पदार्थाः कैवल्योदाहरणानि ते हि कदाचिद् विविधरूपवत्तयोपलभ्यन्ते अथ च तेषां प्रत्यक्षरूपवद्भिः पाषाणकुसुमधात्वादिभी रूपातिरिक्तधर्मेण सादृश्यं नास्ति अतो रूपस्य किरणपरिणामविशेषरूपतया तद्धेतुः स्फटिकादिषु किरणानां समतिर्यगादिः पतनभेदः पुष्पादिषु च प्रकाशकिरणपरावर्तनकारकः पृष्ठसंस्थानविशेष इति । एवं तस्मिन्नेव विषये चित्रवर्णानां पुष्पाणां भिन्नरूपाणि पत्राणि कैवल्योदाहरणानि यतस्तानि परस्परं रूपातिरिक्तेन केनापि धर्मेण न विशिष्यन्ते अतो न द्रव्यजातिविशेषः प्रकाशकिरणपरिणामविशेषरूपस्य रूपस्य हेतुरपितु तत्तद्द्रव्यपृष्ठावयवसंस्थानवैचित्र्यमेव हेतुरिति ज्ञेयम् ॥

। ३ । येषूदाहरणेषु प्रकृतजिज्ञासितो धर्मः पूर्वमविद्यमान आयाति पूर्वं विद्यमानोऽपयाति वा तानि यात्रोदाहरणानीत्युच्यन्ते एतेषामपि दर्शनेन प्रकृतविषयस्याधिको नियमो भवति यतो यः कश्चिद् धर्मः प्रकृतकार्यागमकाल आयाति तस्यापगमकाले त्वपगच्छति स प्रकृतकार्यस्य कारणमिति सिध्यति यथा शुक्लताहेतुविचारे यात्रोदाहरणं काचः। स ह्यखण्डावस्थायां नीरूपश्चूर्णीकृतत्वावस्थायां शुक्लो दृश्यते। एवं जलं स्थैर्यकाले नीरूपमपि फेनीकृतत्वावस्थायां शुक्लतयोपलभ्यत इति॥

। ४ । येषूदाहरणेषु जिज्ञासितो धर्मः प्रतिबन्धकनिवृत्तौ सत्यामुत्कर्षेणाविर्भवति तानि भास्वरोदाहरणानीत्युच्यन्ते यथा वायुगुरुत्वान्वेषणे ताराचलीयनलिका भास्वरोदाहरणं भवति यतो वायुगतगुरुत्वतिरोधानकारिण्यास्तदीयायाः सर्वदा सर्वतः सम्पीडनशक्तेस्तदभ्यन्तरेऽभावात् तत्र पारदस्तम्भधारणादीनि वायुगुरुत्वकार्याणि स्फुटं दृश्यन्त इति। सेयं नलिका कीदृशसामग्र्या प्रोक्तकार्यं प्रदर्शयतीत्येतत् सर्वं वायुगुरुत्वप्रकरणे स्पष्टम्॥

। ५ । अथ यदि क्वचिदेकस्य कार्यस्यानेकानि कारणानि तुल्योपपत्तिकानि प्रथमं भासन्ते तत्र च जातः कतरदेतेषां वस्तुतः कारणमिति सन्देहो येषां दर्शनेनैतदेव वस्तुतः कारणमित्याकारकनिश्चयोत्पत्तिद्वारा निवर्तते तान्युदाहरणानि

दिक्प्रदर्शकोदाहरणानीत्युच्यन्ते मार्गद्वयसङ्गमस्थानवर्त्तितत्तन्मार्गदिक्प्रदर्शकपट्टिकाविशेषसदृशत्वात् तथाहि यदि कस्यचिदेकस्य कार्यस्य कारणत्वमनेकपदार्थेषु सोपपत्तिकं दृश्यते तत्र च सन्दिह्यते कतरदेतेषां वस्तुतः कारणमिति तदा यस्मिन् दृश्यमानः कश्चिद् विशेषोऽनयोरेकेनोपपद्यते नापरेण तादृशोदाहरणजिज्ञासा भवति तान्येव च दिक्प्रदर्शकोदाहरणानि। यथेदं रसायनप्रकरणस्थमुदाहरणम्। रङ्गसीसादयो धातवो भस्माङ्गारादिसंसर्गवर्जनपूर्वकं यथोचिताग्निसंयोगेन किट्टतां नीताः पूर्वगौरवाधिकगौरवा भवन्ति तस्य हेतुरचिरादेव ज्ञातः। तथाहि तत्राविज्ञातगुरुद्रव्यान्तरसंश्लेषेण वा तत्कार्योत्पत्तिः पूर्वलाघवप्रयोजकलघुद्रव्यान्तरविश्लेषेण वा प्राचीनरसायनपण्डितास्तु द्वितीयमेव पक्षं मेनिरे तं च द्रव्यविशेषं तेजःपदेन व्यवजह्रुः तदपगमे सति द्रव्यस्य गुरुत्वं जायत इति हेतुना तस्य गुरुत्वविरोधित्वं च कल्पयामासुः न च तेन निःसन्देहमर्थतत्त्वज्ञानं परीक्षायुक्तेरभावात् अतो दिक्प्रदर्शकोदाहरणदर्शनं कर्तव्यमित्यनुसन्धाय केनचिद् रासायनिकेन परीक्षणं कृतम्। तद्यथा रङ्गखण्डगर्भं निश्छिद्रीकृतं काचपात्रं तुलया मात्वा समर्थाग्निसंयोगेन तत्स्थं रङ्गं किट्टं कृत्वा तत् किट्टगर्भं पात्रं पुनस्तुलया तेन मितम्। पूर्वकमेव तस्य गौरवमुपलभ्य न गुरुरन्तः प्रविष्टो नवा लघुर्बहिर्निर्गत इति निश्चितम्। अथ तत् पात्रं शीतलं कृत्वा तत्रैकं छिद्रं कृतम्। तदा च तत्र बाह्यवायोः

सशब्दं प्रवेशमुपलभ्य तत् पात्रं पुनरुत्तोल्य कतिपयमाषैर्गौर-वाधिक्यमुपलभ्यैतावन्माषमितो वायुरत्र प्रविष्ट इति निश्चितम् । अथ तत् किट्टं पात्राद् बहिर्निष्काश्य पृथक् तुलया साधितम् । तेन च तस्य तावन्माषमितगौरववृद्धिं दृष्ट्वा यः कश्चित् कतिपयमाषमितो वायुः स्वयं परिणम्य तावन्माषमितबाह्यवायुप्रवेशावकाशमकरोत् स एव किट्टीकरणकाले धातुना सम्बध्यत इति निश्चितम् । एवञ्चैतादृशोदाहरणदर्शनात् कल्पनामात्रविलसितो गुरुत्वविरोधितेजोविशेषवादो निरस्तः अथ च प्रकृतकार्यस्य वास्तविककारणं सिद्धं यद् दह्यमानः पदार्थः साधारणवाय्वंशेन संयुज्यते तस्य च गुरुत्वात् किट्टानां गौरवमित्यलं विस्तरेण । इति प्रथमं व्याप्तिग्रहोपाय प्रकरणम् ॥ * ॥

। १ । एतावता प्रतिपिपादयिषितोऽन्वेषणेन व्याप्तिग्रहसम्पादनप्रकारो निरूपितः तत्र चानुमानस्य स्वरूपलक्षणमुक्तम् । अथास्यानुमानसंज्ञकप्रमाणस्य परामर्शद्वारकफलप्राप्तौ विनियोगो वक्तव्यः । तत्रादावनुमानस्य फलद्वारकलक्षणात्मकं तटस्थलक्षणमाह ॥

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अनुमितिकरणमनुमानम् ॥ ३७ ॥

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। १ । परामर्शजन्यं ज्ञानमनुमितिः । व्याप्तिविशिष्टपक्षधर्मताज्ञानं परामर्शः । यथा । वह्निव्याप्यधूमवानयं पर्वत इति

ज्ञानं परामर्शः । तज्जन्यं पर्वतो वह्निमानिति ज्ञानमनुमितिः । यत्र यत्र धूमस्तत्राग्निरिति साहचर्यनियमो व्याप्तिः । व्याप्यस्य पर्वतादिवृत्तित्वं पक्षधर्मता ॥

। २ । विनियोगप्रकारभेदादनुमानस्य द्वैविध्यमाह ॥

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अनुमानं द्विविधं स्वार्थं परार्थं च ॥ ३८ ॥

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। १ । तत्र स्वार्थं लक्षयति ॥

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स्वार्थं स्वानुमितिहेतुः ॥ ३९ ॥

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। १ । तथाहि स्वयमेव भूयोदर्शनेन यत्र यत्र धूमस्तत्राग्नि-रिति महानसादौ व्याप्तिं गृहीत्वा पर्वतसमीपे गतस्तद्गते चाग्नौ सन्दिहानः पर्वते धूमं पश्यन् व्याप्तिं स्मरति यत्र धूमस्तत्राग्नि-रिति । तस्मात् पर्वतो वह्निमानिति ज्ञानमनुमितिरुत्पद्यते तदेतत् स्वार्थानुमानम् । इति द्वितीयं स्वार्थानुमानप्रकर-णम् ॥ ❋ ॥

। १ । अथ परार्थमनुमानं विस्तरेण परीक्षितुं प्रकरणा-न्तरमारभते । तत्रादौ परार्थानुमानलक्षणमाह ॥

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यत् स्वयं धूमादग्निमनुमाय परप्रतिपत्त्यर्थं पञ्चा-वयववाक्यं प्रयुङ्क्ते तत् परार्थानुमानम् ॥ ४०

। १ । यथा पर्वतो वह्निमान् । धूमात् । यो यो धूमवान् स वह्निमान् यथा महानसः । तथाचायम् । तस्मात् तथेत्यनेन प्रतिपादितास्लिङ्गात् परोऽप्यग्निं प्रतिपद्यते । प्रतिज्ञाहेतूदाहरणोपनयनिगमनानि पञ्चावयवाः । पर्वतो वह्निमानिति प्रतिज्ञा। धूमादिति हेतुः । यो यो धूमवान् स वह्निमानित्युदाहरणम् । तथाचायमित्युपनयः । तस्मात् तथेति निगमनम् ॥

। २ । न्यायप्रयोगे कर्तव्ये पञ्चैवावयवाः प्रयोक्तव्या इति न नियमः प्रतिज्ञाहेतूदाहरणरूपेणोदाहरणोपनयनिगमनरूपेण वाऽवयवत्रयेणैव व्याप्तिपक्षधर्मताज्ञानस्य सिद्धतयाऽवशिष्टावयवद्वयवैयर्थ्यात् । नापि प्रतिज्ञैव प्रथमं प्रयोक्तव्येति नियमः । सैव प्रथमं प्रयोक्तव्येति न्यायमतं तु तत्त्वजिज्ञासुकथारूपवादतात्पर्येण । यत्र तु कश्चिन्मताभिमानी स्वमतविरुद्धप्रतिज्ञाश्रवणेनैव कर्णौ पिधास्यति समनन्तराभिधीयमानतद्विषयहेतूदाहरणोपनयान् न च श्रोष्यतीति सम्भाव्यते तदा कतरदेतेषां प्रथमं प्रयोक्तव्यमिति चिन्ता जायते । ग्रीसदेशे तावत् तत्रत्यराज्यस्थितीनां सर्वपौरजानपदश्रेणीपरतन्त्राणामपि वस्तुतो यो वाग्मी समुदितान् सर्वपौरजानपदान् स्वमतं ग्राहयितुं शक्नुयात् तत्परतन्त्रतयोपदेशकौशलनामिका कला महाफलाऽऽसीत् तत्कलाभ्यासोत्तेजकस्यौत्कट्यात् तस्मिन्नेव देशे सा परममुत्कर्षं प्राप यो ऽन्यया नान्यत्र देशे प्राप्तः । अरिस्तुतिलाख्यस्तु वाग्मिनां वाक्याटवफलसिद्धिं दृष्ट्वा येनोपायेनैकदेष्टफलसिद्धि-

ज्ञाता तस्योपायस्य पुनः प्रयोगे तत् फलं प्राप्स्यत इत्यभिप्रेत्य तञ्च विषयं सम्यग्विचार्य ग्रन्थं निबबन्ध यन्मूलकाः सर्व एते साधवस्तत्कलानिबन्धा अधुना युरोपदेशे प्रसिद्धाः सन्ति । अथारिस्तुतिलेन स्वग्रन्थे यदुक्तं तत् सङ्क्षेपेणाह ॥

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अस्मिन् शास्त्रे चत्वारि प्रकरणानि प्रतिज्ञाप्रकरणं हेतुप्रकरणं श्रोतृजनप्रलोभनप्रकरणं वाक्यगुणप्रकरणञ्चेति ॥ ४१ ॥

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। ३ । अस्मिन् शास्त्रे । परार्थानुमानरूपशब्दप्रयोगविचार इत्यर्थः । प्रतिज्ञेत्यादि । इदमत्र प्रतिज्ञाविषयेऽवधातव्यं प्रतिज्ञायाः प्रथममभिधानस्यानावश्यकत्वेऽपि वक्तृभिः प्रतिज्ञाविषयं विधेयं मनसाऽनुसन्धाय वक्तव्यम् । अन्यथाऽमुकमुद्दिश्यामुकं विधेयमित्यनुसन्धानाभावे उपक्रमोपसंहारविरोधः प्रकरणसङ्करश्च प्रसज्यते । यथा । यदि कश्चित् सुवर्णं निरूप्यत इति प्रतिज्ञाय सुवर्णं गुरु महामूल्यं नानाखनिलभ्यं दृढं परीक्षणीयमित्यादीनां बहूनां विधेयानां भिन्नभिन्नप्रकरणसमावेशमकृत्वा तेषामेकप्रकरणेऽव्यवस्थया सङ्क्षेपेण च वर्णनं करिष्यति तर्हि तत्रोपन्यस्ताः साध्यः प्रतिज्ञाः प्रबला हेतवश्चोपेक्षणीया उपक्रान्तविषये लोकानुग्रहासम्पादिकाश्च भवेयुरिति ॥

। २ । अथ हेतुं विभजते ॥

हेतुर्द्वेधा कार्यकारणभावसम्बन्धी तद्भिन्नश्चेति ॥ ४२ ॥

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। १ । यत्र कारणेन कार्यं कार्येण वा कारणमनुमीयते तत्र स्थलद्वयेऽपि हेतुः कार्यकारणभावसम्बन्धी । यत्र तु साध्यहेत्वोः कार्यकारणभावो नास्ति तत्र सामान्यतोदृष्टाख्यस्यानुमानस्योपयोगः । एतानि तत्र क्रमेणोदाहरणानि । मेघोन्नत्या भाविवृष्ट्यनुमानम् । नदीवृद्ध्या भूतवृष्ट्यनुमानम् । कस्यचिदेकस्याम्रस्य पुष्पितत्वमुपलभ्याम्रत्वेन हेतुना देशान्तरवर्त्याम्राणां पुष्पितत्वानुमानं चेति अयमेव सद्धेतुरित्युच्यते व्याप्तिपक्षधर्मतावत्त्वात् ॥

। २ । अथ यदा वादी किमपि साधयति तदा प्रतिवादी तत्र दूषणान्युद्भावयति वाद्युक्तसाधनस्य वास्तविकत्वे तु प्रतिवाद्युक्तैर्दूषणसाधनैरवश्यमसद्भिर्भवितव्यमतः प्रतिवाद्युक्ता हेत्वाभासाः कतिविधाः किंलक्षणकाश्चेत्यवश्यं विचारणीयं तद् यद्यपि प्रथमे ऽध्याये प्राचीनतार्किकभाषया प्रदर्शितं तथापीह शिष्यबुद्धिवैशद्याय नवीनतार्किकभाषया पुनः प्रदर्शयितुं हेत्वाभासान् विभजते ॥

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सव्यभिचारविरुद्धसत्प्रतिपक्षासिद्धबाधिताः पञ्च हेत्वाभासाः ॥ ४३ ॥

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। १ । तत्र सव्यभिचारः साध्याभाववद्वृत्तिः यथा पर्वतो

वह्निमान् प्रमेयत्वादिति प्रमेयत्वस्य वह्न्यभाववति ह्रदे विद्यमानत्वात् ॥

। २ । साध्याभावव्याप्यो विरुद्धो यथाऽयं पुरुषः प्रशंसनीयो दुर्जनत्वादिति । दुर्जनत्वं हि प्रशंसनीयत्वाभावेन निन्द्यत्वेन व्याप्तम् ॥

। ३ । साध्याभावसाधकं हेत्वन्तरं यस्य स सत्प्रतिपक्षो यथा पर्वतो वह्न्यभाववान् जलाद् ह्रदवदिति । पर्वतो वह्निमान् धूमान्महानसवदिति ॥

। ४ । असिद्धः पक्षावृत्तिर्यथा शब्दो गुणश्चाक्षुषत्वादिति । अत्र चाक्षुषत्वं शब्दे नास्ति तस्य श्रावणत्वात् ॥

। ५ । यस्य साध्याभावः प्रमाणान्तरेण निश्चितः स बाधितः यथा वह्निरनुष्णो द्रव्यत्वादिति । अत्रानुष्णत्वं साध्यं तद्भाव उष्णत्वं स्पार्शनप्रत्यक्षेण गृह्यत इति बाधितत्वम् ॥

। ६ । ननु सव्यभिचारविरोधादिप्रक्रियाज्ञातरि प्रतिवादिनि व्यभिचाराद्युद्भावनं सफलं यत्र तु स कामपि शास्त्रप्रक्रियां न वेद तस्मिन् ग्राम्ये जल्पके किंविधं दूषणमभिधानीयमिति चेत् प्रतिवाद्युक्तेऽर्थे यो दोषो वर्तते स दोषो यस्य वाक्यस्यार्थे स्फुटत्वान्निर्विवादस्तादृशं वचनं प्रयोक्तव्यम् । यथा । यो य उदारः स साधुरुदारश्च देवदत्तोऽतोऽयं साधुरिति यदि लौकिकः कश्चित् साधयति तदा शास्त्रप्रक्रियाप्रसिद्धव्यभिचारादिदोषाणां तत्रोद्भावनस्याकिञ्चित्करत्वाद् यो यो मरणधर्मा

स साधुर्मरणधर्मा चायं देवदत्तोऽतोऽयंसाधुरित्युत्तरं प्रयोक्त-व्यमिति ॥

। ७ । अथ जल्पे यदा प्रतिवादी वाद्युपन्यस्तं हेतुं वास्त-विकदोषप्रदर्शनेन दूषयितुं न शक्नोति तदा स छलानि प्रयुङ्-क्ते । तत्र छलं नामार्थान्तरकल्पनया वचनविघातः । स यथा । कौचित् पुरुषौ स्वीयसमस्तदुरितनिवृत्तिः केनोपायेन भविष्य-तीत्युपाध्यायं पप्रच्छतुः । स तु युवाभ्यां चणकविशिष्टोपानदु-पानद्रुपादाभ्यां तीर्थयात्रा कर्तव्या तेन युवयोः पापं चयमेष्य-तीत्युपदिदेश । अथैतौ गुरुमभिवाद्य तदुपदिष्टप्रकारेण प्रत-स्थाते । तत्रैकक्रोशमितमध्वानमतीत्य कठिनचणकनिष्पीड-नातिव्यथितचरण एकोऽपरं प्राह । कथं सखेऽखिन्नो लच्यसे किं तावकौ चरणौ न चणकैर्निष्पीड्येत इति । स एवं पृष्टः कठिनचणकतात्पर्यके गुरुवचसि स्वेन प्रयुक्तं यन्मृदुचणकरूपा-र्थान्तरकल्पनात्मकं छलं तत् प्रकाशितवान् आह च पाकेन मृदूकृतांश्चणकानुपानद्युगले निधायाहं प्रस्थितो न त्वमिव यथोपदिष्टमिति । छलानां विभागा विशेषलक्षणानि सोदा-हरणानि प्रथमेऽध्याये प्रदर्शितानि ॥

। ८ । अथ श्रोतृजनप्रलोभनप्रकरणम् । तथाहि बोध-नात् प्रलोभनस्यायं विशेषो यदेतेन श्रुतार्थविषयिणीच्छा जायते श्रोतृजनप्रलोभने कर्तव्ये प्रस्तुतकार्यविशेषस्य स्पृहणीयत्वं ख्या-

भिमतोपायविशेषस्य तत्प्राप्तिहेतुत्वं चेति द्वयं वक्तव्यं तत्र चोपायस्य प्रस्तुतकार्यसाधकत्वं युक्तिभिः स्थापनीयं परन्तु तस्योपायस्य लोककर्तृकोपादानसिद्धये फलस्यात्यन्तस्पृहणीयत्ववर्णनमावश्यकम् । यत्र तु श्रोतारः फलसौन्दर्ये जातनिश्चया उपायांशे च सन्दिहानास्तत्रोपायवर्णनमेव केवलं कर्तव्यम् । यथा धनविषये । लोको हि धनस्येप्सिततमत्वे जातनिश्चयोऽपि तदर्जनोपायान् न जानाति । यत्र तु ते फलस्योपायस्य च कार्यकारणभावं जानन्तोऽपि फलस्य सौन्दर्यं न जानन्ति तत्र तदेव वक्तव्यम् । यथा धर्मविद्ययोर्विषये । तत्र हि लोका अस्तेयाव्यभिचारानृताभाषणादेर्धर्महेतुतां सततदृढतराभ्यासस्य च विद्याहेतुतां जानन्तोऽपि चौर्यव्यभिचारानृतभाषणादौ निद्रालस्यादौ च धर्मविद्याभ्यामधिकं सुखमस्तीति जानन्ति तत्र वक्त्रा विद्याधर्मयोः सौन्दर्यं प्रदर्शनीयमिति ॥

। ९ । अथ वाक्यगुणप्रकरणम् । प्रसाद ओजो माधुर्यमिति त्रयो वाक्यगुणाः । तत्र प्रसादोऽर्थव्यक्तिः स्पष्टार्थतेति यावत् । सा च सर्ववाक्येष्वपेक्षणीया यतो यथायथा स्पष्टार्थत्वाभावस्तथातथा श्रोतृजनबोधनरूपाभिप्रेतफलजननासामर्थ्यम् । स्पष्टश्चार्थो झटिति चित्तं व्याप्नोति । तदुक्तं काव्यप्रकाशे मम्मटेन । शुष्केन्धनाग्निवत् स्वच्छजलवत् सहसैव यः । व्याप्नोत्यन्यत् प्रसादोऽसौ सर्वत्र विहितस्थितिरिति । ओजस्तु चित्तविस्तारजनको वाक्यस्यधर्मविशेषः । तथाहि अस्ति कश्चिद् वाक्यस्य

विशेषो येन तस्यार्थो न केवलं झटिति मनसि प्रविशत्यपितु चेतसो विस्तारमपि चमत्कारापरपर्यायं जनयति। अयमेवालङ्कारिकैर्दीप्तिरिति व्यवह्रियते। तथाच मम्मटः। दीप्त्यात्मविस्तृतेर्हेतुरोज इति। दीप्तिपदव्यवहार्याया आत्मविस्तृतेरित्यर्थः। चमत्कारस्य च त्रीणि कारणानि पदविशेषाः पदसङ्ख्याविशेषाः पदसंस्थानविशेषाश्चेति। पदानि हि वाक्येषु मुख्यान्यौपचारिकाणि च प्रयुज्यन्ते। तत्र मुख्येषु पदेषु मध्ये तत्तद्व्यक्तिवाचकसंज्ञाशब्दप्रयोगेण समनस्कचक्षुःसन्निकृष्टस्फीतालोकस्थसमीपवर्तिदेवदत्तादिव्यक्तिगताशेषविशेषविषयकसाक्षात्कारवत् स्पष्टरूपेण बोधो भवति। जातिशब्दप्रयोगेण च किञ्चिद्दूरवर्तिदेवदत्तादिविशेष्यकमनुष्यत्वादिप्रकारकतदीयविशेषाविषयकबोधवत् किञ्चित्स्पष्टरूपेण बोधो भवति। एवमन्यैरपि परसामान्यवाचकैः शब्दैर्मन्दालोकस्थदूरतरवर्तिदेवदत्तादिविशेष्यकप्राणित्वादिप्रकारकज्ञानवन्मन्दतमालोकस्थदूरतमवर्तितद्व्यक्तिविशेष्यकयत्किञ्चित्त्वप्रकारकज्ञानवच्चाधिकाधिकास्पष्टा बोधा जायन्ते। एवं चमत्काराविर्भाव औपचारिकपदप्रयोगेण भवति। यथा। सिंहो देवदत्त इत्याकारकौपचारिकवाक्यस्य सिंह इव देवदत्त इत्येतादृशमुख्यवाक्यात् तात्पर्यार्थाविशेषेऽपि चमत्कारकारकत्वमिति। तथा पदसंख्याविशेषस्यापि चमत्कारकारणत्वम्। विस्तरेण प्रसिद्धस्यार्थस्य मितैः पदैः स्फुटीकरणे श्रोतॄणां विशिष्टचमत्कारोदयात्। एवं पदसंस्थानविशेषस्यापि

चमत्कारकारणत्वं यथा प्रश्नवाक्यस्य । अपिच तस्य प्रयोगेण न केवलं चमत्कार आविर्भवति किन्तु तेन श्रोतॄणां मनो विषयविशेषाभिमुखं क्रियते स्वाभिप्रेतार्थसाधकहेतूनप्यहं प्रदर्शयितुं शक्नोमीति वक्तृबुद्धिर्व्यज्यते च । यथा । काके शौचं द्यूतकारे च सत्यं क्लीबे धैर्यं मद्यपे तत्त्वचिन्ता । सर्पे क्षान्तिः स्त्रीषु कामोपशान्ती राजा मित्रं केन दृष्टं श्रुतं वेत्यादौ । अत्र हि राज्ञो मित्रत्वादिकं न दृष्टश्रुतपूर्वमितिनिषेधे तात्पर्यसत्त्वेऽपि चमत्कारविशेषार्थं प्रश्नवाक्यप्रयोग इति ॥

एवं कोमलवर्णघटितपदविन्यासरूपं माधुर्यमोजसोऽविरोधेन सर्वासु रचनास्वपेक्षणीयमिति । इति तृतीयं परार्थानुमानप्रकरणम् ॥ ❋ ॥

अथास्मिन् परार्थानुमानप्रकरणे ये सव्यभिचारादयो हेत्वाभासा निरूपितास्ते वादिद्वयस्य व्याप्तिपक्षधर्मतान्यतरविषयकविप्रतिपत्तौ सत्यामुद्भावनमर्हन्ति । यथा धूमवान् वह्नेरित्यादौ शब्दो गुणश्चाक्षुषत्वादित्यादौ च । तत्र हि यत्र यत्र वह्निस्तत्र तत्र धम इति व्याप्तिं चाक्षुषत्वस्य पक्षभूतशब्दधर्मत्वं चैकोऽभ्युपगच्छति न त्वन्य इति तत्र हेत्वाभासोद्भावनं सङ्गतम् । यत्र तु व्याप्तिपक्षधर्मतयोर्विप्रतिपत्तिर्नास्ति किन्तु तदुभयनिगमनांशे एव । यथा गुरुशिष्ययोः स्वीयसर्वसिद्धान्तव्यक्तिविवादराहित्येऽपि यदि शिष्येण किमप्यसम्बद्धमनुमीयते भ्रान्तिवशात् तर्हि गुरुणा तस्य भ्रमो निरसनीयस्तत्र वादकथायां व्याप्तिपक्ष-

धर्मतयोरुभयसम्मतयोर्दूषणं नोपन्यस्यते किन्तु प्रयुज्यमानन्यायान्तर्गतोदाहरणोपनयनिगमनानां परस्परसम्बन्धराहित्यमुपन्यसनीयम् । यथा यदि कश्चिच्छिष्यो गुरोः समीपे यो यो धूमवान् स वह्निमानिति व्याप्तिं स्वीकृत्य केचित् पर्वता वह्निमन्त इति पक्षधर्मतां च स्वीकृत्य तस्मात् सर्वे पर्वता वह्निमन्त इति निगमयति तर्हि तत्र गुरुणा व्याप्तिपक्षधर्मताविरोधिनो हेत्वाभासत्वस्य शिष्योक्तहेतावुद्भावनं कर्तुमशक्यं व्याप्तिपक्षधर्मतयोः स्वयमपि स्वीकारात् किन्तु तवायं प्रयोगो न्यायो न भवति पर्वतत्वसामानाधिकरण्येन धूमवत्ताया: पर्वतत्वावच्छेदेन वह्निसाधकत्वाभावात् इतरथा वक्ष्यमाणपक्षातिप्रसङ्गदोषापत्तेरित्यादिकं न्यायाकारदूषणं वक्तव्यं सैव च वादकथा । तामिमां विस्तरेण निरूपयितुं प्रकरणान्तरमारभते ॥

अथ वादप्रकरणमारभमाणस्तस्य विषयानुद्दिशति ॥

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उद्देश्यविधेयस्वरूपज्ञानं तदुभयसम्बन्धज्ञानं निगमनं चेति त्रयश्चित्तव्यापारा वादप्रकरणविषयाः ॥ ४४ ॥

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तत्रोद्देश्यविधेययोरन्यतरस्योपस्थितिर्येन व्यापारेण जायते स प्रथमः । उपस्थितस्य तदुभयस्य सम्बन्धो येन व्यापारेण ज्ञायते स द्वितीयः । उदाहरणोपनयार्थज्ञानानन्तरं येन व्यापारेण

तस्मात्तथेति निगमनार्थो ज्ञायते स तृतीयः । फलकरणयोरे-केनैव पदेन व्यवहारस्तु चक्षुरादीन्द्रियाणां तज्जन्यज्ञानानां च प्रत्यक्षपदेन व्यवहारवददुष्टः ॥

तदेतस्य व्यापारत्रयस्य पुरुषान्तरचित्त उत्पादनाय न्याया-त्मकं वचनं प्रयुज्यते । तत्र यस्य श्रवणादुद्देश्यविधेयान्यतरप्रती-त्यनुकूलः श्रोतृचित्तव्यापारो जायते स उद्देश्यभागो विधेयभा-गश्च । येन तु तदुभयसम्बन्धप्रतीत्यनुकूलः श्रोतृचित्तव्यापारो जायते स न्यायावयवः । येन च निगमनाख्यः श्रोतृचित्तव्यापारो जायते स न्यायः । यथा यो यो धूमवान् स वह्निमान् धूमवांश्च पर्वतोऽतोऽयं वह्निमानिति । अत्र हि प्रथमवाक्यस्य धूमवान् वह्निमानित्युद्देश्यविधेयभागौ द्वितीयवाक्यस्य पर्वत इत्युद्देश्यभा-गो धूमवानिति विधेयभागस्ताभ्यां तदुभयस्वरूपोपस्थितौ तद्वा-क्यद्वयेऽनुसन्धीयमानेनास्तिपदेन तदुभयस्य सम्बन्धो बोध्यते । तृतीयवाक्ये तस्मादितिनिर्देशबलात् समुदितवाक्यत्रयरूपेण न्यायेन हेतुज्ञानजन्यज्ञानविशेषरूपं निगमनमुत्पद्यत इति ॥

अथोद्देश्यविधेयभागयोरस्पष्टार्थत्वं न्यायावयवानां बाधिता-र्थत्वं न्यायस्य चानिगमनीयार्थत्वं दोषः । तत्रेह वादप्रकरणे न्यायदोषभूतस्यानिगमनीयार्थत्वस्य सर्वात्मना निराकरणं यै-रुपायैः शक्यं तेषां निरूपणं मुख्यम् । उद्देश्यविधेयभागदोषा-णां न्यायावयवदोषाणां च निरसनन्तु समीचीनवचनप्रयोगेण यावत् सम्भवति तावत् प्रसङ्गतः प्रदर्शयिष्यते ॥

अतएवैतत्प्रकरणाभ्यासान्निगमनसिद्ध्युपयोगिभाषाप्रयोगकौशलं न्यायान्यायविवेककौशलं च प्राप्यते । यस्तु पुरुषश्चित्तव्यापाराणां भाषाप्रयोगपराधीनत्वं कियदस्तीति वेद दुष्टभाषाप्रयोगेण कियन्तो भ्रमसन्देहक्लेशा जायन्त इति चानुसन्धत्ते स एवैतत्प्रकरणाभ्यासस्य सप्रयोजनत्वं विजानाति ॥

तत्रोद्देश्यविधेयभागन्यायावयवोभयदोषाणां न्यायदोषस्य चान्योन्यवैलक्षण्यं द्वेधा । तथाहि । यस्यार्थः स्फुटं न प्रतीयते तस्योद्देश्यविधेयभागत्वं न हीयते यस्य चार्थो बाधितो भवति तस्य न्यायावयवत्वं न हीयते परन्तु येन निगमनं न जन्यते तस्य न्यायत्वं हीयत इत्येकम् । तादृशाः केऽपि विधयो न सम्भवन्ति येषामनुसरणे सर्वत्रोद्देश्यविधेयभागाभ्यां तदुभयप्रतिपत्तिः स्फुटं भवेदवयवानाञ्च बाधिताबाधितार्थत्वविवेकः स्यात् परन्तु ते विधयः सम्भवन्ति येषामनुसरणेऽमुकाकारो न्यायोऽमुकाकारश्च न्यायाभास इति निर्णीयेतेत्यपरम् । एवञ्च प्रकृते यद्विध्यनुसारेणोद्देश्यविधेयभागन्यायावयवन्यायानामाकारपरीक्षया स्वरूपभूतमुद्देश्यविधेयभागत्वं न्यायावयवत्वं न्यायत्वं च निश्चीयते ते विधयोऽत्र वर्ण्यन्ते ॥

न्यायस्य तावदुद्देश्यविधेयबोधकभागद्वयघटितास्त्रयोऽवयवा भवन्ति । ते च प्रत्येकं द्विधा । विधायका निषेधकाश्चेति । तत्र पर्वतो वह्निमानित्याद्याः प्रथमाः । ह्रदो न वह्निमानित्याद्या द्वितीयाः । अत्र चोभयत्रापि वाक्येऽस्तिपदमध्याहर्तव्यं तदेव

च न्यायावयवघटकतया वादप्रकरणे लाघवाद् व्यवह्रियते नत्व-न्यत् पचति गच्छतीत्यादि। तदघटितस्यापि देवदत्तः पचती-त्यादिवाक्यस्य देवदत्तः पचन्नस्तीत्याद्यस्तिपदघटितवाक्यसमा-नार्थत्वात्। तत्रास्तिपदं प्रकृतोद्देश्ये प्रकृतविधेयसम्बन्धबोध-तात्पर्येण प्रयुज्यते न तु स्वरूपसत्ताबोधतात्पर्येण शशविषाण-नरविषाणकूर्मरोमबन्ध्यासुतगगनारविन्दानि कल्पितानि सन्ती-त्यस्मात् शशविषाणादीनां कल्पितत्वस्य बोधात् स्वरूपसत्ताया अबोधाच्चेति ॥

तत्रोद्देश्यभागो विधेयभागश्चैकैकपदरूप इवानेकपदसमुदा-यरूपोऽपि भवति। यथा काश्यां द्वादशवर्षैर्महता श्रमेण देवदत्तादधीतसर्वशास्त्रो मैत्रो बहून् शिष्यान् पाठयन्नस्तीत्या-दि। अस्मात् प्रसङ्गात् पदानि विभजते ॥

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पदानि द्वेधा सापेक्षाणि निरपेक्षाणि चेति। तत्र यानि पदान्तरं विना स्वयमेवोद्देश्यविधेयान्यतर-बोधजनने न समर्थानि तानि सापेक्षाणि। यानि तु नैवंविधानि तानि निरपेक्षाणि ॥ ४५ ॥

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यथा सलोलं दुर् सर्वस्येत्यादिक्रियाविशेषणोपसर्गप्रथमा-न्तनामानि सापेक्षाणि क्रीडति गत ईश इत्यादिपदान्तरं विनो-द्देश्यविधेयान्यतरबोधजननासमर्थत्वात्। चैत्रो मैत्रो घटः पटः

शुक्लः कृष्ण इत्यादीनि तु निरपेक्षाणि तदन्यतरबोधने स्वयमेव समर्थत्वात् । अपिचातएव सापेक्षाणां न स्वत उद्देश्यविधेयान्यतरभागरूपत्वं किन्तु तदन्यतरभागैकदेशत्वमेव । निरपेक्षाणां तु स्वत एवोद्देश्यविधेयान्यतरभागरूपत्वमिति । अथोद्देश्यविधेयभागयोः प्रत्येकं विभागानाह ॥

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उद्देश्यविधेयभागौ प्रत्येकमनेकधा ॥ ४६ ॥

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तथाहि । १ । तौ द्वेधा । सजातीयबहुव्यक्तिवाचकौ मनुष्यो नदी पर्वत इत्याद्यौ । एकमात्रव्यक्तिवाचकौ चैत्रो गङ्गा हिमालयोऽयंश्च इत्याद्यौ । २ । पुनर्द्वेधा । धर्मिवाचकौ घटशुक्लडित्थाद्यौ । धर्मवाचकौ रूपरसघटत्वशुक्लत्वाद्यौ । ३ । पुनरपि द्वेधा । सविशेषबोधकौ परमेश्वरहिमालयघटपटाद्यौ । निर्विशेषबोधकौ चैत्रडित्थशुक्लत्वाद्यौ । । ४ । पुनश्च द्वेधा । भावाश्रयबोधकौ गुरूष्णशुक्लघटपटप्रभृती । अभावाश्रयबोधकौ लघुशीताघटापटप्रभृती । ५ । पुनरपि द्वेधा । ससम्बन्धिकौ पितृमातृभ्रातृस्वामिसेवकाद्यौ । असम्बन्धिकौ घटपटकुड्यकुसूलमहानसचत्वरगोष्ठाद्यौ ॥

अथ वादप्रकरणस्य द्वितीयविषयभूतं न्यायावयवस्वरूपं निरूपणीयं तत्रादौ न्यायावयवानां वाक्यविशेषरूपत्वेन तत्प्रसङ्गाद् वाक्यानि विभजते ॥

वाक्यं द्वेधा उद्देश्यविधेयसम्बन्धबोधमात्रपरं तद-
न्यच्च ॥ ४७ ॥

पर्वतो वह्निमानित्यादिकं प्रथमम् । द्वितीयं द्वेधा तर्कपरं विकल्पपरं चेति । तत्र यदि वह्निमान् न स्यात् तर्हि धूमवान् न स्यादित्यादिकं तर्कपरम् । जगदाकस्मिकं वा स्याच्चेतनकर्तृकं वा स्यादित्यादिकं विकल्पपरम् । वादप्रकरणेतूद्देश्यविधेयसंबंधबोधमात्रे तात्पर्यादुद्देश्यविधेयसम्बन्धबोधमात्रपराणामेव वाक्यानां प्रयोगो न तु तर्कविकल्पपराणामपीति । अथ न्यायावयवान् विभजते ॥

विधायको निषेधकश्चेति न्यायावयवानां प्रथमो
विभागः ॥ ४८ ॥

यथा पर्वतो वह्निमानिति ह्रदो न वह्निमानिति च ॥

यथार्थमयथार्थञ्चेत्येवंविधो यो विषयविभागाधीनो विभागस्तस्य तत्तद्विषयस्वरूपपरविद्याविषयतया प्रकृते तस्य नोद्देशः ॥

अथ न्यायावयवानां द्वितीयो विभाग उच्यते ॥

उद्देश्यतावच्छेदकावच्छेदेन विधेयबोधक उद्दे-

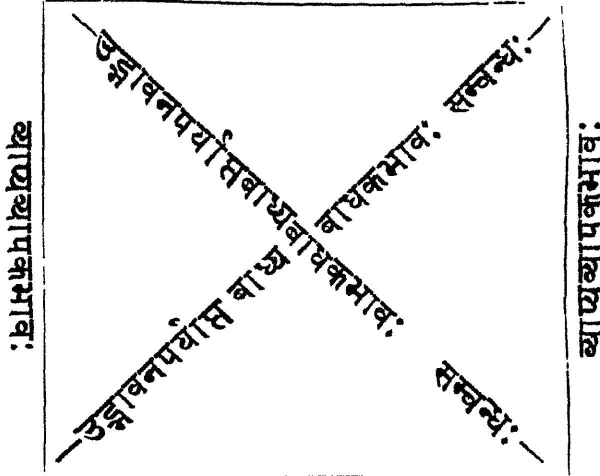
श्यतावच्छेदकसामानाधिकरण्येन विधेयबोधक-
श्चेति तेषां द्वितीयो विभागः ॥ ४९ ॥

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यथा सर्वे पर्वता वह्निमन्तः केचित् पर्वता वह्निमन्त इत्यादि। उद्देश्यवाचकपदस्यावच्छेदकावच्छेदेन बोधकत्वं सर्वेत्यादिशब्दैर्ज्ञायते सामानाधिकरण्येन बोधकत्वं च केचिदित्यादिपदैर्ज्ञायते परन्तु विधेयस्यावच्छेदकावच्छेदेन सामानाधिकरण्येन वा बोधकत्वं येन प्रकारेण ज्ञायते स उच्यते। तथाहि निषेधकाः सर्वेऽवयवा नियमेन सर्वनिषेध्यव्यक्तिपराः यथा ह्रदो न वह्निमानित्यत्र वह्निमत्पदं सर्वा वह्निमद्व्यक्तीर्विषयीकरोति। विधायकास्तु सर्वा विधेयव्यक्तीर्विषयीकुर्वन्तीति न नियमः यथा पर्वतो वह्निमानित्यत्र महानसचत्वरगोष्ठादिवह्निमद्व्यक्तिभिः सह पर्वतस्याभेदो न बुध्यते इति। तस्मात् यथाऽवच्छेदकावच्छेदेन विधेयबोधकैर्न्यायावयवैः सर्वाण्युद्देश्यानि विषयीक्रियन्ते तथा सर्वैर्निषेधकैः सर्वा निषेध्यव्यक्तय इति। ननु यद् यद् द्रव्यं तत् तद् गुणवदित्यादिसमव्याप्तिस्थलेऽवच्छेदकावच्छेदेन विधेयबोधकोऽपि न्यायावयवः सर्वा विधेयीभूतगुणव्यक्तीर्विषयीकरोत्येव द्रव्यातिरिक्ते गुणानामसत्त्वादिति चेत् सत्यम्। परन्तु विषयस्वभावे ज्ञाते सतीदं ज्ञायते नतु न्यायावयवस्याकारदर्शनमात्रेण। इह तु वाक्याकारेण स्फुटानामेव वाक्यधर्माणां विवेचनमित्युक्तम् ॥

अथात्र प्रकरणे करिष्यमाणन्यायाकारविचारस्य सौकर्यार्थं तत्तन्न्यायावयवविशेषाणां सङ्केतभूता वर्णा उच्यन्ते। यथा। अवच्छेदकावच्छेदेन विधायको न्यायावयव (अ) इत्यनेन बोद्धव्यः अवच्छेदकावच्छेदेन निषेधक (ए) इत्यनेन। सामानाधिकरण्येन विधायक (इ) इत्यनेन। सामानाधिकरण्येन निषेधक (ओ) इत्यनेनेति। एतेषां चतुर्णां न्यायावयवविशेषाणां परस्पराभिमुख्ये नियामकं सम्बन्धचतुष्टयम्। तथाहि। (अ) (ओ) इत्येतयोः परस्परं (ए) (इ) इत्येतयोश्च परस्परमुद्भावनपर्याप्तबाध्यबाधकभावः सम्बन्धः। यथा सर्वे पर्वता वह्निमन्तः केचित् पर्वता न वह्निमन्त इत्येतयोः। न कोऽपि महाह्रदो वह्निमान् केचिद्ध्रदा वह्निमन्त इत्येतयोश्च। अ इ इत्येतयोः परस्परं ए ओ इत्येतयोश्च परस्परं व्याप्यव्यापकभावः। यथा सर्वे पर्वता वह्निमन्तः केचित् पर्वता वह्निमन्त इत्येतयोर्न कोऽपि महाह्रदो वह्निमान् केचिद्ध्रदा न वह्निमन्त इत्येतयोश्च। अ ए इत्येतयोरन्योन्यमुद्भावनपर्याप्ताधिकबाध्यबाधकभावः। यथा सर्वे पर्वता वह्निमन्तो न कोऽपि पर्वतो वह्निमानित्येतयोः। इ ओ इत्येतयोर्विरोधिव्याप्यत्वं यथा केचित् पर्वता वह्निमन्तः केचित् पर्वता न वन्हिमन्त इत्येतयोरिति। अत्र प्रकरणे उद्भावनपर्याप्तबाध्यबाधकभावस्यैव विशेषेण विचारणं न त्वन्यस्य बाध्यबाधकभावस्य। सर्वे मनुष्याः साधवो न वा कोऽपि मनुष्यः साधुरित्येतयोर्मतयोः केचिन्मनुष्या न साधवः केचिद्वा साधव

इत्येतादृशोद्भावनेन निरासमसम्भवादवच्छेदकावच्छेदेनानुमितौ सामानाधिकरण्येन बाधस्य प्रतिबन्धकत्वात् । यदत्र न्यायावयवानामाभिमुख्यमुक्तं तदालेख्यरचनया स्पष्टं प्रतीयतेऽतस्त्रालेख्यं प्रदर्श्यते ॥




अथ न्यायावयवानां परिवर्तनप्रकारश्चिन्त्यते तत्र सूत्रम् ॥

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प्रकृतन्यायावयवस्योद्देश्यविधेयभागयोर्विधेयोद्देश्यभागत्वविधानं तन्न्यायावयवस्य परिवर्तनमुच्यते इति ॥ ५० ॥

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अत्र च वादप्रकरणे तुल्यवित्तिवेद्यपरिवर्तनस्यैवाकारदर्शनलभ्यतया तादृशपरिवर्तनमेवात्र विचार्यते तथाहि । यत् प्रकृतन्यायावयवीयोद्देश्यविधेयभागयोर्विधेयोद्देश्यभागत्वं तत् स्व-

लपरिवर्तनमित्युच्यते । यथा न कोऽपि महाह्रदो वह्निमानित्यस्य न कोऽपि वह्निमान् महाह्रद इत्येवं सरलमेव परिवर्तनं तुल्यवित्तिवेद्यार्थं भवति । प्रकृतवाक्यस्थेन येन पदेन स्वीयसर्वार्थग्रहणं न कृतं तस्य वाक्यस्य परिवर्तनेऽपि तेन पदेन स्वीयसर्वार्थग्रहणं यत्र न क्रियते स एव तुल्यवित्तिवेद्यसरलपरिवर्तनस्य विषयः । अतश्च एकारद्योत्यस्यावच्छेदकावच्छेदेन निषेधवाक्यस्योद्देश्यविधेयभागयोः स्वार्थसर्वव्यक्तिग्राहकतया इकारद्योत्यस्य सामानाधिकरण्येन विधायकवाक्यस्य च तदुभयभागयोः स्वार्थसर्वव्यक्तिग्राहकत्वाभावात् तयोरेव वाक्ययोः सरलपरिवर्तनविषयता । अकारद्योत्ये त्ववच्छेदकाच्छेदेन विधायके वाक्ये विधेयभागस्य स्वार्थसर्वव्यक्तिग्राहकत्वाभावात् तस्य सरलपरिवर्तनं तुल्यवित्तिवेद्यं न भवति । न हि यो यो धूमवान् स वह्निमानितिज्ञाने सत्यवश्यं यो यो वह्निमान् स धूमवानिति ज्ञायते तथासति वह्निमत्पदस्य पूर्वत्र सर्वस्वार्थाग्राहकस्योत्तरत्र सर्वस्वार्थग्राहकत्वप्रसक्तेः । अतस्तस्य परिवर्तने कर्तव्ये वह्निमत्पदस्यार्थसङ्कोचं कृत्वा केचिद् वह्निमन्तो धूमवन्तो भवन्तीत्येवमाकारो विधेयः स च तुल्यवित्तिवेद्यार्थ एव । तदेतत् पदार्थसङ्कोचेन परिवर्तनमित्युच्यते । एतच्च एकारद्योत्यस्यावच्छेदकावच्छेदेन निषेधवाक्यस्यापि सम्भवति । अथ ओकारद्योत्यस्य सामानाधिकरण्येन निषेधकवाक्यस्य परिवर्तने उद्देश्यभागस्य यावदर्थग्राहित्वे सत्यसति वा विधेयभागस्य पूर्वत्रायावदर्थग्राहक-

स्यैव तत्र यावदर्थग्राहकतया तद्वाक्यस्य तादृशपरिवर्तनासम्भवेन तदीयं निषेधकत्वं परित्यज्याभावविधायकवाक्यत्वं स्वीकर्तव्यम् । तथासति तस्य इकारयोत्यत्वं सम्पद्यते । ततश्च सरलमेव परिवर्तनं तस्य तुल्यवित्तिवेद्यार्थं भवति । यथा । कानिचिद् द्रव्याणि न रूपवन्तीत्यस्य वाक्यस्य कानिचिद् रूपवन्ति न द्रव्याणीत्येवं परिवर्तनं न तुल्यवित्तिवेद्यं भवति पूर्वमयावदर्थग्राहिणो द्रव्यपदस्येह यावदर्थग्राहिताप्रसङ्गात् किन्तु तस्य वाक्यस्य रूपवन्निषेधकत्वं परित्यज्य रूपवद्भेदविधायकत्वस्वीकारेण निषेधस्य विधेयकोटौ प्रवेशनं कृत्वा कानिचिन्नीरूपाणि द्रव्याणि भवन्तीति सरलमेव परिवर्तनं कर्तव्यम् । तदेतत् विधेयोद्देश्यान्यतरभागे निषेधप्रवेशनेन परिवर्तनमित्युच्यते । एतच्च अकारद्योत्यस्यावच्छेदकावच्छेदेन विधायकवाक्यस्यापि भवति यथा यो यो धूमवान् स वह्निमानित्यस्य यो यो न वह्निमान् स न धूमवानित्युद्देश्यविधेयभागद्वये निषेधं प्रवेश्य परिवर्तनं तुल्यवित्तिवेद्यार्थं भवति । एवञ्चोक्तप्रकारत्रयान्यतमेन न्यायावयवानां परिवर्तनं भवति । तत्र ए इ इत्येतयोः सरलपरिवर्तनम् । अ ए इत्येतयोः पदार्थसङ्कोचेन परिवर्तनम् । अ ओ इत्येतयोरुद्देश्यभागविधेयभागयोर्विधेयभागमात्रे च क्रमेण निषेधान्तर्भावात् परिवर्तनमिति ॥

अथ न्यायस्वरूपं विविच्यते । तत्र प्रतिज्ञाद्यास्त्रयो निगमनान्ता वा त्रय एव न्यायस्यावयवा इति वेदान्तपरिभाषाकारमतं यद्य-

प्यस्मत्सम्मतं तथापीह प्रकरणे निगमनान्तावयवत्रयघटितन्याये-नैव व्यवहारः क्रियते। तस्य च न्यायस्य द्वौ भागौ साधकभागः साध्यभागश्च। यतस्तत्र व्याप्तिविशिष्टपक्षधर्मत्वेन सिद्धः साध-कतयाऽभिमतो हेतुरुदाहरणोपनयाभ्यां प्रथममुपन्यस्यते तद-नन्तरमसिद्धं किमपि पूर्वोक्तहेतुवल्लभ्यं साध्यं निगमनेनोच्यते॥

वादप्रकरणस्य च न्यायाकारैकविषयकत्वात् तादृश एव न्याय इह प्रयोक्तव्यो यत्रत्यसाध्यहेतुपक्षवाचकपदानामर्थपरिचयं विनापि तदाकारमात्रदर्शनात् तस्य निगमनीयार्थता सिध्येत् यथा यो यो हेतुमान् स साध्यवान् पक्षश्च हेतुमानित्येताभ्या-मुदाहरणोपनयाभ्यां पक्षः साध्यवानिति निगमनं तद्घटकपक्ष-साध्यहेतुपदैर्यस्य कस्याप्यर्थस्य विवक्षणेऽप्यवश्यं निर्याति। इत-रेषामपि सन्न्यायाकाराणामेष एवाकारः पर्यवस्यति॥

अथ यस्मिन् सन्न्याये उदाहरणमुपनयो वा बाधितार्थस्तत्र तदुभयमिश्रणफलभूतं निगमनं बाधितार्थमेव भवतीति न नि-यमः। यत्र चोदाहरणमुपनयो वा सम्भावनागर्भस्तत्र निगम-नमपि सम्भावनागर्भम्। तत्राद्यं यथा यो यो मनुष्यः स साधुरि-त्येवंविधं बाधितार्थमप्युदाहरणं रामो मनुष्य इत्युपनयसहका-रेण रामः साधुरित्येवंविधमबाधितार्थं निगमनं जनयति कंसो मनुष्य इत्येवंविधोपनयसहकारेण तु कंसः साधुरित्येवंविधं बाधितार्थमेव निगमनं जनयति। यत्र तु निगमनं बाधितार्थ-मुपलभ्यते तत्रावश्यमुदाहरणमुपनयो वा बाधितार्थो भवति

तयोरबाधितार्थत्वे निगमनस्य बाधितार्थत्वनियमात् इदं च बा-
धिताबाधितार्थत्वं न वादप्रकरणे चिंत्यते प्रयोगाकारपरिचय-
मात्रेण दुर्ज्ञेयत्वात् ॥

एवं क्वचित् तर्कवाक्यमपि कस्यचित् प्रकृतविषयस्य निर्णयार्थं प्रयुज्यते । तर्कवाक्यं हि वादिद्वयाभिमतोदाहरणविशेषसहकृतमुपनयवाक्यं भवति । अतस्तत् प्रकृतविषयविरुद्धार्थबाधं साधयति । यथा यो यो धूमवान् स वह्निमानिति यो यो वह्न्यभाववान् स धूमाभाववानिति च यः स्वीकरोति स पर्वतस्य धूमवत्त्वं स्वीकृत्य यदि पर्वते वह्निर्नास्तीति वदेत् तर्हि तस्य खण्डनार्थं यदि पर्वतो वह्न्यभाववान् स्यात् तर्हि धूमाभाववान् स्यादिति व्याप्यारोपेण व्यापकारोपरूपस्तर्कः प्रयुज्यते तेन च धूमस्य पर्वते त्वया स्वीकाराद् धूमाभावबाधेन वह्न्यभावोऽपि बाधित इति सिध्यति तेन च पर्वतो वह्निमानिति निर्णीयते । असत्तर्कादसतः सतो वा निर्णये नियमाभावेऽपि सत्तर्कात् सत एव निर्णय इति नियमात् इत्थञ्च तर्कवाक्यस्य क्वचित् प्रतिपक्षखण्डनार्थमुपयोगेऽपि न वादप्रकरणे तस्य प्राधान्येन व्यवहारः उद्देश्यविधेयसंबन्धमात्रपरत्वाभावात् ॥

अथ यो यो हेतुमान् स साध्यवान् पक्षश्च हेतुमानतः पक्षः साध्यवानित्येतस्य न्यायाकारस्य सन्न्यायाकारत्वमूलं प्रदर्शयितुमेष नियमोऽपरिस्तुतिलाख्येन प्रयुज्यते यदवच्छेदकावच्छेदेन

विधीयते निषिध्यते वा तत् सामानाधिकरण्येन विधातुं निषेद्धुं वा शक्यमिति ॥

येषु तु न्यायाकारेष्वयं नियमोऽनायासेन न विनियोगयोग्य-स्तत्र सन्न्यायाकारत्वनिर्णयसौकर्यायान्ये नियमाः प्रयुज्यन्ते ते यथा ॥

। १ । न्यायस्य त्रय एव भागाः पक्षबोधकः साध्यबोधको हेतुबोधक इति । तत्र निगमन उद्देश्यसमर्पकः पक्षबोधकः । तत्रैव विधेयसमर्पकः साध्यबोधकः । यस्यार्थे साध्यसम्बन्ध उदाहरणेन प्रदर्श्यते उपनयेन च पक्षसम्बन्धः प्रदर्श्यते स हे-तुबोधकः । अतो यत्रैको व्याप्तिमत्तयोक्तोऽन्यश्च पक्षधर्मत-योक्तस्तत्रैकस्य हेतोः पक्षसाध्योभयसम्बन्धप्रदर्शनाभावात् पक्ष-साध्ययोः परस्परं सम्बन्धो न निगच्छतीति ॥

। २ । अतएव न्यायस्य त्रय एव स्वतन्त्रा अवयवाः । तत्र हेतोः साध्यसम्बन्धप्रदर्शकमुदाहरणं प्रथमः । हेतोः पक्षसम्बन्धबोधक उपनयो द्वितीयः । पक्षस्य साध्यसम्बन्धप्र-दर्शकं निगमनं तृतीयः । प्रतिज्ञाहेतू नैयायिकैर्न्यायावयवत्वेन स्वीक्रियमाणावपि नोपनयनिगमनाभ्यामत्यन्तमतिरिच्येते ॥

। ३ । तत्र यदि हेतुबोधको भागः सन्दिग्धार्थस्तर्हि तत्रै-केन शब्देन विवक्षिता अनेके हेतवः सम्भाव्यन्ते । तच्च सन्दि-ग्धार्थत्वं क्वचिन्नानार्थत्वप्रयुक्तं यथा या या रुक् सा तमोविरो-धिनी ज्वरश्च रुगतोऽयं तमोविरोधीत्यादौ । एवं क्वचित् स्व-

वाच्यसमुदायैकदेशमात्रपरत्वं हेतुबोधकभागस्य सन्दिग्धार्थता-प्रयोजकं यथा यो यः शुक्लः स रूपं कृष्णश्च रूपमतः कृष्णः शुक्ल इत्यादौ रूपशब्देन यदि सर्वे वर्णा गृहीताः स्युस्तदा कृष्णस्य शुक्लस्य च सकलवर्णात्मकत्वज्ञानात् कृष्णस्य शुक्लात्मकत्वं सिध्येत् । तदेव नास्ति विधायकवाक्यीयविधेयांशस्य स्ववाच्यसर्वव्यक्तिपरत्वाभावात् । अतो न्यायशरीरेऽन्तत एकदा हेतुवाचकपदेन स्वार्थसर्वव्यक्तिपरेण भवितव्यं तच्च द्वेधा सम्भवति उद्देश्यतावच्छेदकावच्छेदेन विधायकनिषेधकावयवोद्देश्यभागत्वेन वा निषेधवाक्यीयनिषेध्यपरशब्दत्वेन वा । तथाच निगमनीयोद्देश्यविधेययोरेकस्य सर्वहेतुव्यक्तिसम्बन्धित्व उक्तेऽपरस्य कतिपयहेतुव्यक्तिसम्बन्धे च निर्दिष्टे सति निगमनं न्याय्यमिति ॥

। ४ । यत् पदमुदाहरणोपनयान्यतरस्मिन् वर्तमानं सत् न सर्वस्वार्थग्राहकं न तन्निगमने सर्वस्वार्थपरं भवितुमर्हति । येन पदेन पूर्वं स्वार्थैकदेश एव गृहीतस्तेन निगमने सर्वस्वार्थग्रहणे न्याये चतुर्थपदसत्त्वप्रसङ्गात् । साध्यातिप्रसङ्गपक्षातिप्रसङ्गयोरापत्तेः । तत्र साध्यातिप्रसङ्गो यथा यो यश्चतुष्पात् स प्राणी पक्षी च न चतुष्पादतः स न प्राणीत्यादिन्यायान्तर्गतोदाहरणवाक्यस्थः प्राणिशब्दो न सर्वप्राणिव्यक्तीर्विषयीकरोति विधायकवाक्यीयविधेयभागत्वात् । न प्राणीति निगमने तु स एव सर्वप्राणिव्यक्तीर्विषयीकुरुते निषेधवाक्यान्तर्गतनिषेध्यभा-

गत्वात् । पक्षातिप्रसङ्गो यथा यद् यद् बौद्धशास्त्रोक्तं तदना-दरणीयं धर्मश्च बौद्धशास्त्रोक्तोऽतो धर्मोऽनादरणीय इत्यादौ निगमनस्य धर्मत्वावच्छेदेनानादरणीयत्वविधितात्पर्यकत्वे पक्षातिप्रसङ्गात् । उपनये धर्मपदेन बौद्धशास्त्रोक्तधर्मस्यैव ग्रहणमित्यस्य निर्विवादत्वात् । अत्र च धर्मत्वसामानाधिकरण्येन निगमनं न्याय्यं साध्यातिप्रसङ्गस्थले तूदाहरणोपनयाभ्यां किमपि निगमनं न न्याय्यमिति विशेषः ॥

। ५ । निषेधवाक्यरूपाभ्यामुदाहरणोपनयाभ्यां न किमपि निगम्यते ताभ्यामेकस्मिन् हेतौ व्याप्तिपक्षधर्मत्वयोरप्रदर्शनात् यथा न कश्चिदपि जलवान् वह्निमान् न च कश्चिच्छैवालवान् वह्निमानित्येताभ्यां किमप्यसिद्धं न सिध्यति ॥

। ६ । उदाहरणोपनयान्यतरस्य निषेधवाक्यत्वे निगमनमपि निषेधवाक्यात्मकमेव न्याय्यमिति । हेतोः पक्षसाध्यान्यतरसम्बन्धाभावे प्रतीते पक्षसाध्ययोः परस्परसम्बन्धप्रतीतेरयोगात् । इत्थञ्च यत्र निगमनं निषेधवाक्यरूपं तत्रावश्यमुदाहरणोपनयान्यतरन्निषेधवाक्यात्मकमिति सिद्धम् ॥

एभिः षड्भिर्विधिभिः सर्वे उद्देश्यविधेयसम्बन्धमात्रपरावयवत्रयघटितन्यायाकाराः परीक्षितुं शक्यन्ते । अतएवैतत् स्पष्टं प्रतीयते यत् सामानाधिकरण्येन विधेयपराभ्यामुदाहरणोपनयाभ्यां किमपि न निगच्छति तत्र हि क्वचिद्धेतुवाचकपदस्य स्ववाच्यसमुदायैकदेशमात्रपरत्वं स्यात् क्वचित् पक्षातिप्रसङ्गः

स्यात् क्वचिच्च साध्यातिप्रसङ्गः स्यात् तथाहि इकारश्चोत्याभ्यां सामानाधिकरण्येन विधिवाक्यरूपाभ्यामुदाहरणोपनयाभ्यां न किमपि निगमनं निर्याति हेतुभागस्य स्ववाच्यसमुदायैकदेश-मात्रपरत्वात् । इकारश्चोत्यस्य सामानाधिकरण्येन विधिवाक्य-त्मकोदाहरणस्यौकारश्चाप्यस्य तथाविधनिषेधवाक्यात्मकोपनयस्य च योगान्निगमनं निषेधवाक्यात्मकं निर्याति तत्र च येन पदेन पूर्ववाक्यद्वये सर्वे स्ववाच्या न विषयीकृतास्तादृशपदेन सर्वस्ववा-च्यविषयीकरणात् साध्यभागातिप्रसङ्गः । यथा कश्चित् प्राणी तीक्ष्णबुद्धिः कश्चिच्च पशुर्न तीक्ष्णबुद्धिरतः स न प्राणीत्यादौ केवलमुपनयस्थेन तीक्ष्णबुद्धिरितिपदेन सर्वाणि स्ववाच्यानि वि-षयीकृतानि न त्वन्येन केनापि तदेव च हेतुवाचकमिति स्वीक-र्तव्यमन्यथा हेतुवाचकपदस्य स्वार्थसमुदायैकदेशमात्रपरत्वदो-षप्रसङ्गात् । निगमने तु प्राणिशब्दः सर्वान् स्ववाच्यान् विष-यीकरोति पूर्ववाक्यद्वये तु स तथा न करोति अतस्तत्र साध्य-भागातिप्रसङ्गः । अत एवोदाहरणोपनयान्यतरस्य सामाना-धिकरण्येन विधेयपरत्वे निगमनमपि सामानधिकरण्येन विधे-यपरमेव न्याय्यं यथा पूर्वोदाहृते यद् यद् बौद्धशास्त्रोक्तं तत् तदनादरणीयं धर्मश्च बौद्धशास्त्रोक्तोऽतोऽयमनादरणीय इत्या-दावुपनयस्थधर्मपदस्य धर्मविशेषपरत्वान्निगमनेऽपि धर्मविशेष एवानादरणीयत्वोपसंहार उचितो धर्मसामान्ये तदुपसंहारे पक्षातिप्रसङ्गात् । अपिचावच्छेदकावच्छेदेन विधेयपराभ्यामु-

दाहरणोपनयाभ्यामवच्छेदकावच्छेदेन विधेयपरमेव निगमनं निर्यातीति न नियमः यथा यद् यत् सुवर्णं तन्महामूल्यं यच्च सुवर्णं तत् खनिजमतः कश्चित् खनिजो महामूल्य इत्येव निगच्छति नतु सर्वे खनिजास्तथेति उपनयस्थखनिजशब्देन सर्वखनिजानामग्रहणान्निगमने तस्य सर्वखनिजग्राहकत्वाभावादिति ॥

अथ ये सङ्केताः पूर्वं न्यायावयवानां विधायकत्वनिषेधकत्वयोरवच्छेदकावच्छेदेन सामानाधिकरण्येन वा विधेयपरत्वस्य द्योतका । अ । ए । इ । ओ । इति चत्वारः प्रदर्शितास्तेषामन्योन्ययोजनेन ये य आकाराः सम्पद्यन्ते तेषां विचारः क्रियते । तथाहि । चतुर्विधेनोदाहरणेन प्रत्येकं चतुर्विधोपनयसंयोजने कृते षोडश न्यायावयवयुगलानि निष्पद्यन्ते तेषां च चतुर्विधैर्निगमनैः प्रत्येकं संयोजने कृतेऽवयवत्रयात्मकस्य न्यायस्य चतुष्षष्टिराकाराः सिध्यन्ति । तेषां मध्ये य एकादश दर्शयिष्यमाणव्यवस्थया साधवस्त इह प्रपञ्च्यन्ते । इतरे तु सर्वथा सदोषा आकारास्ते स्वयं सुधीभिः परीक्षार्थमूहनीयाः ॥

तत्र सर्वे साधवः सर्वेषु हेतूपन्यासप्रकारेषु न साधवः किन्तु कश्चित् क्वचित् । हेतूपन्यासप्रकारास्तु त्रयः । यत्रोदाहरणे हेतुरुद्देश्य उपनये च विधेयः स प्रथमः । यत्र हेतुरुभयत्रापि विधेयः स द्वितीयः । यत्रोभयत्रापि हेतुरुद्देश्यः स तृतीयः । चतुर्थोऽपि प्रथमविरुद्धः प्रकारः कैश्चिदुक्तः सोऽस्माभिः पार्थक्येन

न व्यवहरिष्यते हेतूपन्यासप्रकारज्ञानेन केवलं हेतोरुद्देश्यविधेयान्यतरभागान्तर्भावो विषयीक्रियते न्यायावयवानां विधायकत्वं निषेधकत्वं उद्देश्यतावच्छेदकावच्छेदेन तत्सामानाधिकरण्येन वा विधिपरत्वमित्येतत्तु यथेच्छं विवक्षणीयं पुरुषेणेति । उदाहरणं साध्यहेत्वोः सम्बन्धबोधकं वाक्यम् । उपनयः पक्षहेतुसम्बन्धबोधकं वाक्यम् । निगमनं पक्षसाध्यसम्बन्धबोधकं वाक्यम् । तेन तेषां स्थानभेदेऽपि न तथात्वहानिः । परन्तु प्रथममुदाहरणं तत उपनयस्ततश्च निगमनमिति सम्प्रदायस्तु न हेयः सरलत्वात् ॥

सर्वस्मिन् हेतूपन्यासप्रकारे सर्वे साधुन्यायाकाराः साधवो न भवन्तीत्युक्तं तद् यथा ॥

। इ । उदाहरणम् ॥

। अ । उपनयः ॥

। इ । निगमनम् । इत्ययं न्यायाकारः ॥

कश्चिद् हेतुमान् साध्यवान् ॥

यो यो हेतुमान् स पक्षः ॥

अतः कश्चित् पक्षः साध्यवानित्येवंविधे तृतीये हेतूपन्यासप्रकारे साधरपि ॥

कश्चिद् हे० सा० ॥

यः पक्षः स हे० ॥

अतः कश्चित् प० सा० इत्येवंविधे प्रथमे हेतूपन्यासप्रकारे न

साधुः हेतुवाचकपदस्योदाहरणोद्देश्यभागत्वेनोपनयविधेयभागत्वेन च स्वार्थसर्वव्यक्तिपरत्वाभावात् ॥

एवम् । अ । उदाहरणम् ॥

। ए । उपनयः ॥

। ए । निगमनम् इति न्यायाकारो ॥

यः सा० स हे० ॥

न कश्चित् प० हे० ॥

अतो न प० सा० इत्येवंविधे द्वितीये हेतूपन्यासप्रकारे साधुरपि ॥

यो हे० स सा० ॥

न कश्चित् प० हे० ॥

अतो न प० स० इत्येवंविधे प्रथमे हेतूपन्यासप्रकारे न साधुः साध्यातिप्रसङ्गदोषात् निगमनस्थसाध्यभागस्य निषेधकवाक्यस्थनिषेध्यभागतया सर्वस्वार्थव्यक्तिपरत्वात् उदाहरणे तु विधायकवाक्यस्थविधेयभागतया तस्यातथात्वात् ॥

एवम् । अ । उदाहरणम् ॥

। अ । उपनयः ॥

। अ । निगमनम् इति न्यायाकारो ॥

यो हे० स सा० ॥

यः प० स हे० ॥

अतः प० सा० इत्येवंविधे प्रथमे हेतूपन्यासप्रकारे साधुरपि ॥

यो हे० स सा० ॥

यो हे० स प० ॥

अतः प० सा० इत्येवंविधे तृतीये हेतूपन्यासप्रकारे न साधुः पक्षातिप्रसङ्गदोषात् उपनयस्थपक्षभागस्य विधायकवाक्यीयविधेयभागतया सर्वस्वार्थव्यक्तिपरत्वाभावात् निगमनस्य त्ववच्छेदकावच्छेदेन विधयपरतया तदन्तर्गतपक्षभागस्य स्वार्थसर्वव्यक्तिपरत्वात् ॥

अथोक्तानां चतुष्षष्टिन्यायाकाराणां त्रिभिर्हेतूपन्यासप्रकारैः संयोजने कृते पक्षसाध्यातिप्रसङ्गहेतुसङ्कोचरूपदोषत्रयनिरासपरस्य पूर्वोक्तनियमषट्कस्याविरोधिनः प्रतिहेतूपन्यासप्रकारं षट् षडाकारा आकारदोषरहिता उपलभ्यन्ते। तेषु चाष्टादशसु मध्ये ते चत्वार उपेक्ष्यन्ते येष्ववच्छेदकावच्छेदेन निगमनं न्याय्यमपि विहाय सामानाधिकरण्येन निगमनमन्तर्भवति। ते च प्रथमे हेतूपन्यासप्रकारे । अ । अ । इ । इति । इ । । अ । ओ । इति द्वौ । द्वितीये च । ए । । अ । ओ । इति । अ । ए । । ओ । इति द्वाविति । तथाचोर्वरितानां चतुर्दशानां न्यायाकाराणां मध्ये यस्य यस्मिन् हेतूपन्यासप्रकारे साधुता यथाच द्वितीयतृतीयहेतूपन्यासप्रकारसम्बन्धिनां सर्वेषां निर्दोषाकाराणां यथायथं प्रथमहेतूपन्यासप्रकारसम्बन्धिन्यायाकाररूपता तत् सर्वमनायासेन सङ्क्षेपेण स्मरणारूढं कर्तुमेष श्लोक उपन्यस्यते ॥

बार्बरकेलारेण्ट् दारियो पेरियो प्रथमस्य । केसरे कामेस्त्रेस् पेस्तीनो बरोको द्वितीये । दाराप्ती दिसमिस् दातीसी पेलाप्तोन् तृतीये । अपिच बोकार्दो पेरीसो चेति विदोषाः न्यायानामाकारा हेतूपन्यासभेदसम्बद्धा इति ॥ ५१ ॥

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अत्र प्रथमपादस्था (बकारककारदकारपकारा) उत्तरपादोपन्यस्तानां स्वारम्भपदद्योत्यानां न्यायाकाराणां प्रथमपादोपन्यस्ततत्तदक्षरारम्भपदद्योत्यन्यायाकाररूपतासम्भवं द्योतयन्ति । तत्र च न्यायाकाराणां न्यायाकारान्तररूपताविधाने स्वाव्यवहितपूर्ववर्त्यज्द्योत्यन्यायावयवस्य सरलपरिवर्तनं कर्तव्यमिति ) सकारः ) सूचयति । पदार्थसङ्कोचेन परिवर्तनं कर्तव्यमिति ) पकारः ) सूचयति । उदाहरणोपनययोः स्थानस्वरूपयोर्मिथः परिवर्तनं कर्तव्यमिति (मकारः) सूचयति । (ककारस्तु) स्वाव्यवहितपूर्ववर्त्यज्द्योत्यन्यायावययस्य निष्कासनं तत्स्थाने तत्रत्यनिगमनविपरीतावयवपूरणं च कर्तव्यमिति सूचयति । सोऽयं श्लोको न्यायाकारसाध्वसाधुभावविवेकेच्छुभिरभ्यसनीय इति ॥

अपिचैवंविधसङ्केतविचारणे कृते अकारद्योत्यनिगमनं प्रथम एव हेतूपन्यासप्रकारे न्याय्यम् । निषेधकमेव निगमनं द्वितीये । सामानाधिकरण्येन विधेयपरमेव निगमनं तृतीये इति

स्फुटीभवति । निषेधकमेव निगमनं द्वितीये न्याय्यमित्यत्र बीजं तु तत्रत्य उदाहरणे उपनये च हेतोर्विधेयतया तदन्यतरस्य निषेधवाक्यत्वमन्तरा हेतुवाचकपदस्य स्वार्थसर्वव्यक्तिपरत्वासम्भवात् तदन्यतरस्य निषेधवाक्यत्वे निगमनस्य निषेधवाक्यत्वनियमादिति ॥

तत्रेह वादप्रकरणे ये चत्वारो न्यायाकाराः प्रथमहेतूपन्याससप्रकारसम्बन्धिनस्तद्रूपताविधानं सर्वेषां निर्दोषन्यायाकाराणां यदा चिकीर्षितं तदा पूर्वसिद्धयोरुदाहरणोपनयवाक्ययोरेवाभ्युपगमः कर्तव्यो न तु निर्दिष्टपक्षसाध्यहेत्वतिरिक्तः कोऽपि भागः पूरणीयः परन्तु यत्रास्त्युपयोगस्तत्र तुल्यवित्तिवेद्यार्थं सरलपरिवर्तनं पदार्थसङ्कोचेन परिवर्तनं वा कर्तव्यमित्यभ्यनुज्ञायते । तथाकृते सति च प्रथमहेतूपन्यासप्रकारे कदाचिद् यथापूर्वमेव निगच्छति कदाचिच्च तादृशं निगच्छति यस्य तुल्यवित्तिवेद्यार्थं परिवर्तनं पूर्वसिद्धनिगमनस्वरूपं भवतीति ॥

तत्र शिष्यबुद्धिवैशद्याय तत्तद्धेतूपन्यासप्रकारसम्बन्ध्येकैको न्यायाकार उदाह्रियते ॥

प्रथमे हेतूपन्यासप्रकारे ॥

यो हे० स सा० ॥

यः प० स हे० ॥

अतः प० सा० इत्येवंविधे ॥

। बार् । यो यो धूमवान् स वह्निमान् उदाहरणम् ॥

। ब । सर्वे पर्वता धूमवन्तः उपनयः ॥

। र् । अतः सर्वे पर्वता वह्निमन्तः निगमनम् ॥

द्वितीये हेतूपन्यासप्रकारे ॥

यः सा० स हे० ॥

न कोऽपि प० हे० ॥

अतो न कोऽपि प० सा० इत्येवंविधे ॥

। काम् । यो यो वह्निमान् स धूमवान् उदाहरणम् ॥

। एस् । न कोऽपि पर्वतो धूमवान् उपनयः ॥

। वेस् । अतो न कोऽपि पर्वतो वह्निमान् निगमनम् ॥

तृतीये हेतूपन्यासप्रकारे ॥

यो हे० स सा० ॥

यो हे० स प० ॥

अतः प० सा० इत्येवंविधे ॥

। दा । यो यो धूमवान् स वह्निमान् उदाहरणम् ॥

। राप् । यो यो धूमवान् स पर्वतः उपनयः ॥

। ती । अतः कश्चित् पर्वतो वह्निमान् निगमनम् इति ॥

अथ द्वितीयतृतीयहेतूपन्यासप्रकारसम्बन्धिनां न्यायाकाराणां प्रथमहेतूपन्यासप्रकारसम्बन्धिन्यायाकाररूपताविधानस्य प्रकारः प्रदर्शितस्तस्य स्पष्टप्रतिपत्तय उदाहरणानि प्रदर्श्यन्ते । तथाहि ॥

। दा । यो यो धूमवान् स वह्निमान् ॥

। राम् । यो यो धूमवान् स आर्द्रेन्धनवान् ॥

। ती । अतः कश्चिदार्द्रेन्धनवान् वह्निमाम् इत्यादिस्थलेऽवच्छेदकावच्छेदेन विधायकवाक्यात्मकोपनयसूचकस्य (अ) इत्यक्षरस्योत्तरवर्तिना पकारेण तदुपनयस्य पदार्थसङ्कोचेन परिवर्तनं कर्तव्यमिति बोध्यते तथाचोपनयस्य सामानाधिकरण्येन विधायकवाक्यत्वे सम्पन्ने इकारद्योत्यतासम्पत्त्या तस्य न्यायाकारस्य ॥

। द । यो यो धूमवान् स वह्निमान् ॥

। रि । कश्चिदार्द्रेन्धनवान् धूमवान् ॥

। यी । अतः कश्चिदार्द्रेन्धनवान् वह्निमान् इत्येवंविधप्रथमहेतूपन्यासप्रकारसम्बन्धिन्यायाकाररूपता सम्पद्यते । अयमर्थो दकारेण द्योत्यते ॥

एवम् ॥

। काम् । यो यो धूमवान् स वह्निमान् ॥

। एस् । न कोऽपि महाह्रदो वह्निमान् ॥

। तेस् । अतो न कोऽपि महाह्रदो धूमवान् इत्यादिस्थले अवच्छेदकावच्छेदेन निषेधवाक्यात्मकोपनयद्योतकस्य (ए) कारस्योत्तरवर्तिना सकारेण तदुपनयस्य सरलपरिवर्तनं कर्तव्यमिति बोध्यते तेन च तस्य (ए) कारद्योत्यत्वं सम्पद्यते । अवच्छेदकावच्छेदेन विधिवाक्यात्मकोदाहरणद्योतकस्य (अ)

कारस्योत्तरवर्तिना मकारेण पूर्वोत्तरवाक्ययोरुदाहरणोपनय-योर्मिथः स्थानपरिवर्तनं कर्तव्यमिति बोध्यते निगमनस्यापि सरलपरिवर्तनं कर्तव्यमिति तद्द्योतकाजुत्तरसकारेण बोध्यते तथाच तस्य न्यायाकारस्य ॥

। के । न कोऽपि वह्निमान् महाह्रदः ॥

। ला । यो यो धूमवान् स वह्निमान् ॥

। रेण्ट् । अतो न कोऽपि धूमवान् महाह्रदः इत्येवंविधप्रथमहेतूपन्यासप्रकारसम्बन्धिन्यायाकाररूपता सम्पद्यते अयमर्थः ककारेण बोध्यते । अत्रत्यं निगमनं च सरलपरिवर्तनेन पूर्वनिगमनं भवितुमर्हतीति । अथ बरोको बोकार्दो इत्यनयोराकारयोर्बकारादिपदेन व्यवहारे किं बीजमितिचेदुच्यते यदा कश्चन वादी बरोको बोकार्दो इत्येतदाकारद्वयघटके निगमने विप्रतिपद्यते तदा तेन स्वीकृतयोरुदाहरणोपनययोरन्यतरस्य प्रतिक्षेपः प्रसज्यते तथाच तदन्यतरस्य स्थाने निगमनविपरीतं वाक्यमुपन्यस्य तदन्यतरविपरीतं निगमनमुद्भावनीयं तत्तु तर्कप्रयोगे पर्यवस्यति ॥

तथाच तयोराकारयोर्बार्बर इत्येतदाकारता सम्भवतीति द्योतयितुं बकारादिपदेन तद्व्यवहारः । यथा ॥

। ब । यो यो धूमवान् स वह्निमान् ॥

। रोक् । केचित् पर्वता न वह्निमन्तः ॥

। ओ । अतः केचित् पर्वता न धूमवन्त इत्यादिस्थले सा-

मानाधिकरण्येन निषेधात्मकोपनयद्योतकस्योकारस्योत्तरवर्तिना ककारेण तस्योपनयस्य परित्यागस्तत्स्थाने प्रकृतनिगमनविपरीतार्थकवाक्यान्तरसमावेशश्च कर्तव्य इति बोध्यते। अत्र च प्रकृतनिगमनविपरीतं वाक्यं । सर्वे पर्वता धूमवन्त इति। तथासति सर्वे पर्वता वह्निमन्त इति निगमनं प्रकृतोपनयविरुद्धं निर्यास्यति अनेन क्रमेणास्य न्यायाकारस्य ॥

। बार। यो यो धूमवान् स वह्निमान् ॥

। ब। सर्वे पर्वता धूमवन्तः ॥

। र। अतः सर्वे पर्वता वह्निमन्त इत्येवमाकारता सम्पद्यते ॥

एवम् ॥

। बोक्। केचिन्महाह्रदा न वह्निमन्तः ॥

। आर्। सर्वे च महाह्रदाः शैवालवन्तः ॥

। दो। अतः केचिच्छैवालवन्तो न वह्निमन्त इत्याद्याकारस्य प्रदर्शितक्रमेणोदाहरणं परित्यज्य तत्स्थाने निगमनविपरीतं वाक्यमुपन्यसनीयं प्रकृतोदाहरणविपरीतं च निगमनं सम्पादनीयमिति क्रमेण ॥

। बार्। सर्वे शैवालवन्तो वह्निमन्तः ॥

। ब। सर्वे च महाह्रदाः शैवालवन्तः ॥

। र। अतः सर्वे महाह्रदा वह्निमन्त इत्याकारता सम्पद्यते इत्यलं विस्तरेण ॥

अथ यत्रैकन्यायघटकमुदाहरणमुपनयश्च न्यायान्तरेण साध्यते तत्र पूर्वपूर्वन्यायसाधनार्थमुत्तरोत्तरन्यायोपन्यासान्न्यायश्रेणीप्रसज्यत इति तत्रत्यं विषयवैचित्र्यं शिष्यबुद्धिवैशद्यार्थं वर्ण्यते । तथाहि । युक्लिदाख्येनायं सिद्धान्तः प्रतिज्ञातो यदेकं । अ क ग । इत्येतद्वर्णत्रयद्योत्यं त्रिभुजं समभुजमस्तीति । इयं च प्रतिज्ञा प्रतिज्ञात्रयरूपा । तत्र । अक । भुजेन । अग । भुजस्तुल्य इत्येका । अक । भुजेन । कग । भुज इति द्वितीया । कग । भुजेन । अग । भुज इति तृतीया । आसु प्रथमां साधयितुमेष न्यायः प्रयुज्यते । यथा ॥

। बार् । यत्र यत्रैकवर्तुलनिरूपितव्यासार्द्धत्वं तत्र परस्परसाम्यमिति उदाहरणम् ॥

। ब । । अक । भुजे । अग । भुजे चैकवर्तुलनिरूपित व्यासार्द्धत्वमिति उपनयः ॥

। र । अतः । अक । भुजे । अग । भुजे च परस्परसाम्यमिति निगमनम् ॥

अयं न्यायो (बार्बर) इत्याकारकत्वान्न्यायदोषरहितः ॥

अथ निगमनं वा स्वीकर्तव्यमुदाहरणोपनयान्यतरस्य वा बाधः कर्तव्य इतिरीत्या यदि कश्चिदेतन्निगमनमस्वीकुर्वन्नुदाहरणवाक्यस्य बाधमुपन्यस्यति तर्हि तत्साधनाय न्यायान्तरमुपन्यसनीयं तद्यथा ॥

। बार् । यो यः सप्रयोजनशास्त्रीयसिद्धान्तः स स्वीकर्तव्य

इत्युदाहरणम्

। ब । एकवर्तुलव्यासार्द्धानां परस्परसमानत्वं चेत्रमिति-

सिद्धान्त इत्युपनयः ॥

। र । अत एकवर्तुलव्यासार्द्धानां परस्परसमानत्वं स्वीक-

र्तव्यमिति निगमनम् ॥

अयमपि न्यायो । बार्बर । इत्याकारकत्वान्न्यायदोषरहि-तः । तत्रोदाहरणं स्वतः सम्भवि क्लिदीयसिद्धांतपरिग-णप्रकरणस्थमेकमपि प्रतिषेधतः पुरुषस्य युक्लिदमते कथाप्रवे-शाभावादुपनयोऽपि कथाप्रवेशमिच्छता ऽवश्यं स्वीकर्तव्य इति ॥

अथ (अग) भुजस्य (अक) भुजस्य चैकवर्तुलनिरूपित व्यासार्धतायाः स्वतः सम्भवित्वाभावादुपनयस्य यदि बाधः शंक्यते तर्हि तत्साधनायापि न्यायान्तरं प्रयोक्तव्यं तद् यथा ॥

। बार् । यत्र यत्र कल्प्यमाने वर्तुले यत् केन्द्रं यच्च व्यासा-

र्द्धं प्रयोजनवशात् कल्प्यते तत् तत्रानुमन्तव्य-

मित्युदाहरणम् ॥

। ब । अत्रापि कल्प्यमाने वर्तुले (अ) केन्द्रं (अग)

व्यासार्द्धं (अक) रूपापरव्यासार्द्धं च कल्प्यत

इत्युपनयः ॥

। र । अतः (अक) (अग) इत्येतौ भुजौ (अ

केन्द्रककल्प्यमानवृत्ते व्यासार्धत्वेनानुमन्तव्यौ इति निगमनम् ॥

अयमपि न्यायो (बार्बर) इत्याकारत्वान्न्यायदोषरहितः अत्रतूपनयवाक्यं स्वतः सम्भवि । कल्पकस्य स्वकल्पनाविषये पारतन्त्र्याभावात् उदाहरणवाक्यं तु युक्तिदेन सह कथाप्रवेशमिच्छता पुरुषेण पूर्वोक्तयुक्त्याऽवश्यं स्वीकर्तव्यमिति ॥

अनयैव रीत्या (अक) भुजस्य (कग) भुजस्य च परस्परसाम्यं सिध्यति ॥

अथ (अग) भुजस्य (कग) भुजस्य च परस्परसाम्यसाधने युक्तिप्रदर्शनमवशिष्टं तदर्थमेष न्यायः प्रदर्श्यते । यथा ॥

। बार् । यत्र यत्र प्रत्येकमेकवस्तुसाम्यं तत्र परस्परसाम्यमित्युदाहरणम् ॥

। ब । (अग) भुज (अक) भुजे च (अक) भुज रूपैकवस्तुसाम्यमित्युपनयः ॥

। र । अतः (अग) भुजे (कग) भुजे च परस्परसाम्यमिति निगमनम् ॥

अयमपि न्यायो (बार्बर) इत्याकारकत्वान्न्यायदोषरहितः तत्रोपनयवाक्यसिद्धिः प्रदर्शिता । उदाहरणवाक्यस्य तु युक्तिदसिद्धान्तत्वादेव स्वीकार आवश्यक इति ॥

एवंरीत्या यत्र न्यायश्रेणी परीच्यते तत्र क्वचित् प्रतिवादिना

न्यायदोषोद्भावने नैयायिको वादी तं न्यायं परित्यजेदिति सम्भाव्यते । अथवा वादिनः स्वतः सम्भवित्वेनाभिमते प्रतिवादिनश्च जिज्ञासितप्रमाणके कस्मिंश्चिदुदाहरण उपनये वा कथापर्यवसानं स्यादिति सम्भाव्यते । तथाहि । अत्र पक्षे स्वतः सम्भवित्वेनाभिमते विषये स्वयं प्रमाणप्रदर्शनस्याशक्यतया तत्प्रदर्शनमन्तरेण च प्रतिवादिनिवृत्तेरशक्यतया प्रमाणप्रदर्शनव्यतिरिक्तं सर्वं वादिभाषितं जल्पकोलाहलमात्रं स्यादिति कथासमाप्तिरेव प्राप्नोति इति । चतुर्थं वादप्रकरणम् ॥

॥ समाप्तोऽनुमानखण्डः ॥



अथ प्रथमेऽध्याये तृतीयसूत्रव्याख्याने शब्दस्यानुमानविधया प्रामाण्यमुक्तमष्टमसूत्रे चाप्तोपदेशरूपत्वं शब्दस्य लक्षणमुक्तं तत्र वाक्यप्रयोक्तुराप्ततायाः ग्राहकं वक्तुर्गुणत्रयमाह ॥

निष्कपटत्वं साक्षाद्द्रष्टृत्वं सदसद्विवेचनसामर्थ्यं चेति त्रीण्याप्तत्वलिङ्गानि ॥ ५२ ॥

अयं भावः सकपटवाक्ये तावत् प्रामाण्यं सन्दिग्धं किञ्च निष्कपटोपि पुमान् यदि तं विषयं साक्षान्नाद्राक्षीत् तर्हि तद्विषये तथ्यं वक्तुं न शक्नोति एवं निष्कपटोपि साक्षाद्द्रष्टापि तद्विषय-

गतसदसद्भागविवेचनसामर्थ्यस्याभावे तथ्यं वक्तुं न शक्नोति तथाच तद्विषयवक्तुः पुरुषस्याप्ततायामुक्तलिङ्गत्रयमावश्यकं । एवमन्येषां वाक्यमनुवदतोऽप्याप्तत्व एतदेव लिङ्गम् तत्र परकीयवाक्यस्यैव वचनविषयत्वात् ॥

अथ म्यूरमहाशयकृताया मतपरीक्षायाः प्रथमखण्डस्याः षडशीत्युत्तरचतुःशततमाद्या द्वासप्तत्युत्तरपञ्चशततमान्ताः श्लोका उक्तविषयस्पष्टीकरणार्थमिहोपन्यस्यन्ते । ते यथा ॥

य: पूर्वभूतवृत्तान्तः पारम्पर्य्येण लभ्यते ॥
स जातु प्रत्ययार्होऽस्ति जातु नास्तीति बुध्यते ॥ ४८६ ॥
वृत्तान्तः कश्चिदेको हि सप्रमाणः प्रतीयते ॥
प्रमाणवर्जितोऽन्यस्तु प्रतिभाति परीक्षणात् ॥ ४८७ ॥
अतोऽमुका पुरावृत्तकथा विश्वासमर्हति ॥
न वेत्येतद्विवेकाय तद्विशेषो विचार्य्यतां ॥ ४८८ ॥
असौ कथा कदा कुत्र कस्य वक्त्रादजायत ॥
श्रोतारश्चादिमस्तस्याः कीदृशाः कति चाभवन् ॥ ४८९ ॥
असौ समुद्भवात् पश्चाद् आशु ग्रन्थे समार्प्यत ॥
उतैतिह्येन पूर्वेषां मुखमात्रादवाप्यत ॥ ४९० ॥
इत्यादीनां चरित्रस्य विशेषाणां परीक्षणात् ॥
तत् सत्यमस्त्युतासत्यमिति विद्युर्विवेकिन: ॥ ४९१ ॥
किन्त्वस्मिन्विषये येन स्फुटः स्यादाशयो मम ॥
तदर्थं तं यथाशक्ति विस्तरेण प्रपञ्चये ॥ ४९२ ॥

स्वभावदेशकालादिहेतुभेदसमुद्भवं ॥
वैलक्षण्यं मनुष्येषु महदस्तीति बोधसि ॥ ४९३ ॥
केचिज्जना जडा मूर्खा निर्विवेकाः पराश्रयाः ॥
अज्ञाना आशुविश्वासा ग्रामीणा अपि चासते ॥ ४९४ ॥
अन्ये तु साक्षरा दक्षा विद्यावन्तो विचारिणः ॥
स्वतन्त्रबुद्धयोऽनाशुविश्वासास्तत्त्वलिप्सवः ॥ ४९५ ॥
नानादेशीयलोकाश्च पूर्वमज्ञानविप्लुताः ॥
शेषे विद्योन्नतिं प्रापुरिति लोके प्रसिध्यति ॥ ४९६ ॥
कस्यापि निद्वतो लोका अविज्ञा यावदासते ॥
विचारशक्तिरेतावत् तेषां तिष्ठति निर्बला ॥ ४९७ ॥
अतः सम्भाविनी काऽस्ति प्रमाणैश्चान्विता कथा ॥
का नास्ति चेति तादृशैर्लोकैः सम्यङ् न बुध्यते ॥ ४९८ ॥
ते यं यं पूर्ववृत्तान्तं निशाम्यन्ति पुरातनम् ॥
स्वकर्णैस्तं पिबन्त्याशु विश्वसन्त्यपरीक्ष्य च ॥ ४९९ ॥
कस्यापि नीद्वतो लोका यदा विज्ञास्तु जज्ञिरे ॥
तदा विवेचिका शक्तिस्तेषामत्यन्तमेधते ॥ ५०० ॥
अतः का सप्रमाणाऽस्ति निष्प्रमाणा च का कथा ॥
इत्यादिनः परीक्षायै ते कल्पन्ते सुबुद्धयः ॥ ५०१ ॥
किमप्याख्यानमाकर्ण्य प्राक्तनं तादृशा जनाः ॥
तत्राशु न प्रतीयन्ति परीक्षन्ते तु सर्वशः ॥ ५०२ ॥
तस्मादाद्याश्चरितस्य श्रोतारः कीदृशोऽभवन् ॥

इत्येकं तत्त्वसंसक्तैर्निश्चेतव्यमवादिषं ॥ ५०३ ॥
अन्यच्च पूर्ववृत्तस्य वक्ता कोऽभवदादिमः ॥
कीदृशश्चेति निश्चेतुं योग्यं तत्त्वबुभुत्सुभिः ॥ ५०४ ॥
अतासौ सज्जनो ज्ञानी स्वार्थहीनश्चरित्रवित् ॥
उत स्वार्थान्वितो वक्रश्चासीदित्यादि दृश्यतां ॥ ५०५ ॥
केचिद्धि पूर्ववृत्तान्तवक्तारो वक्रचेतसः ॥
स्वार्थायावास्तवी वार्त्ताः कल्पयित्वा प्रचक्षते ॥ ५०६ ॥
किञ्चामुका कथा कस्मिन् काले कुत्रोदपद्यत ॥
ग्रन्थे कदाऽर्पिता चासीदिति निश्चेतुमर्ह्यते ॥ ५०७ ॥
चेद् ग्रन्थेऽनर्पिता कापि कथा दीर्घान्तरावधि ॥
प्राचां वाङ्मात्रतोऽश्रावि तर्हि संकोचिता भवेत् ॥ ५०८ ॥
ग्रन्थेष्वनर्पिताः सत्यः पुरावृत्तकथा यतः ॥
विकारं प्रायशः सर्वाः प्राप्नुवन्त्युत्तरोत्तरं ॥ ५०९ ॥
यदुक्तं प्राक्तनाख्यानपरीक्षाविषये मया ॥
दृष्टान्तद्वयरूपेण तद् एतर्हि प्रपञ्चये ॥ ५१० ॥
प्राक्काले पारसीकीयो महाशक्तिरधीश्वरः ॥
भीमामक्षौहिणीं नीत्वा देशं यावनमाक्रमीत् ॥ ५११ ॥
तस्मादभिक्रमाद् विद्वन् प्रायशस् त्रिशताधिके ॥
सहस्रे द्वे तु वर्षाणामद्य यावद् व्यतीयतुः ॥ ५१२ ॥
अल्पेऽपि निर्भयाः सन्तो यवना युत्सु भूरिषु ॥
शत्रोरक्षौहिणीं जित्वा स्वदेशाद् निरकासयन् ॥ ५१३ ॥

यत्कालेऽभिक्रमं चक्रे पारसीकेश्वरो बली ॥
तदानीं यावने देशे बालः कश्चिदविद्यत ॥ ५१४ ॥
असौ तु यौवनं प्राप्य हेरदत्ताभिधो जनः ॥
चरित्रं तस्य युद्धस्य तथ्यमाख्यातुमिष्टवान् ॥ ५१५ ॥
तदानीं तन्महायुद्धसर्ववृत्तान्तसाक्षिणः ॥
पुमांसो भूरयो जीवदवस्थायामवित्सत ॥ ५१६ ॥
अमीषां साक्षिणां वक्त्राद् बुधो निश्चित्य विस्तरं ॥
गद्येन तच्चरित्राणि हेरदत्तः प्रणीतवान् ॥ ५१७ ॥
ग्रन्थादौ पारसीकाना मन्येषाञ्च विदेशिनां ॥
मनुष्याणां पुरावृत्तं ग्रन्थकारेण कथ्यते ॥ ५१८ ॥
तत्तद्विदेशिलोकानां पुरावृत्तबुभुत्सया ॥
स दूरेष्वपि पर्य्यटीद् विदेशेषु महोद्यमः ॥ ५१९ ॥
तत्रत्यानां च लोकानां पुरावृत्तविदां मुखा ॥
तत्तद्देशीयवृत्तान्तं स चिरत्नं समग्रहीत् ॥ ५२० ॥
यत्काले तत्प्रबन्धस्य रचना तु समाप्यत ॥
तदा क्वचि स संसत्सु यवनानामपठ्यत ॥ ५२१ ॥
तदा सर्वप्रदेशीया यवना यत्र संययुः ॥
काचिल्लीला व्यवाहारि महती तत्र नीवृति ॥ ५२२ ॥
लोकेषु तत्र लीलायां सञ्चितेष्वेकदा त्वसौ ॥
हेरदत्तोऽखिलान्सभ्यान् स्वं प्रबन्धमशुश्रुवत् ॥ ५२३ ॥
ततः पश्चाद् अथेनाख्यां नगरीं यावनीं सुधीः ॥

स्वग्रन्थश्रावणाकांक्षी हेरदत्तः समागमत् ॥ ५२४ ॥
सा पूस्तु पूर्षु सर्वासु यावनीषु महायशाः ॥
चातुर्य्यात् कीर्त्तिताश्चासन् जनास्तत्रनिवासिनः ॥ ५२५ ॥
अथेनावासिनश्चामी वीराशंसनमास्थिताः ॥
शत्रूणां खण्डनेऽल्पेऽपि महाशौर्य्येण येतिरे ॥ ५२६ ॥
तदाऽथेनीयपौरेषु संगृहीतेषु संसदि ॥
तदग्रे स्वकृतं ग्रन्थं ग्रन्थकारोऽपठीत् पुनः ॥ ५२७ ॥
श्रोतॄणां भूरयोऽमीषां सैन्या भूत्वा स्वयं पुरा ॥
स्वदेशाक्रान्तिवेलायां पारसीकानयुत्सत ॥ ५२८ ॥
ये चान्ये बालका असन् देशाक्रान्तेरनेहसि ॥
ते स्वस्वतातवक्त्रेभ्यस्तद्वार्त्तां शुश्रुवुर्मुहुः ॥ ५२९ ॥
अतः प्रबन्धकारोऽसौ यच्चरित्रं तदाऽपठीत् ॥
तत्सारं पूर्वतः सर्वं तच्छ्रोतारोऽप्यवेदिषुः ॥ ५३० ॥
अथेनावासिनश्चामी लोकास्तस्मिन्ननेहसि ॥
ग्रामीणा निर्विवेका वा मूर्खा वा नह्यवित्सत ॥ ५३१ ॥
तन्मध्ये भूरयो दक्षा विद्यावन्तो विचारिः ॥
स्वतन्त्रबुद्धयोऽनाशुविश्वासाश्चाभवन् बुध ॥ ५३२ ॥
साधारणा जनश्चापि तत्रत्यास्तीक्ष्णबुद्धयः ॥
वार्त्ताजिज्ञासवश्चासन्निति लोके प्रसिध्यति ५३३ ॥
लोकानां तादृशां साक्षात् सञ्चितानां सभान्तरे ॥

महायुद्धस्य वृत्तान्तं हेरदत्तोऽपठीत् तदा ॥ ५३४ ॥
अतः स तादृशान् विज्ञान् दृष्ट्वाँल्लोकानवास्तवं ॥
वृत्तान्तं श्रावयेदित्थं मम बुद्धौ न सम्भवेत् ॥ ५३५ ॥
अमुष्मिन् यावने देशे प्रदेशा भूरयोऽभवन् ॥
तत्तत्प्रदेशराजत्वं भिन्नं भिन्नमवित्त च ॥ ५३६ ॥
तत्तत्प्रदेशजा लोका राज्यानेकत्वहेतुतः ॥
परस्परेर्ष्यिणो ऽभूवन्नित्याख्यानविदो विदुः ॥ ५३७ ॥
अतस्तत्तत्प्रदेशीया यद्यच्छौर्य्यमकुर्वत ॥
तल्लेशमप्यपह्नोतुं हेरदत्तस्तु नाशकत् ॥ ५३८ ॥
अत्युक्त्या चेत्तु तन्मध्ये सोऽश्लाघिष्यत कानपि ॥
तं नूनं तर्ह्यनिन्दिष्यन् लोका अन्यप्रदेशजाः ॥ ५३९ ॥
अतः सोऽमुष्य युद्धस्य यं प्रबन्धं प्रणीतवान् ॥
स सर्वथाऽस्ति विश्वास्यो विद्वन्नत्र न संशयः ॥ ५४० ॥
असौ प्रोक्तः प्रबन्धस्तु कृतोऽमुष्मिन्ननेहसि ॥
तदैव प्रचचालेति सम्यगस्त्यवधारितं ॥ ५४१ ॥
आतत्प्रणीतिवेलातः सन्ततं ह्यधुनावधि ॥
तद्ग्रन्थसत्त्वम् आहान्यग्रन्थकारपरम्परा ॥ ५४२ ॥
तद्ग्रन्थसत्त्वमेते ये ग्रन्थकारा वदन्ति तु ॥
प्रसिद्धास्ते स्वयं सन्ति प्राचीनाश्च न संशयः ॥ ५४३ ॥
एतस्य विस्तरं विद्वन् चेत् परीक्षितुमिच्छसि ॥
तर्ह्यस्मिन्विषये ग्रन्थाः सुलभाः सन्ति भूरयः ॥ ५४४ ॥

तथा च यः प्रबन्धोऽसौ हेरदत्तकृतो मया ॥
इदानीमुच्यते तस्य निश्चिताऽस्ति चिरत्नता ॥ ५४५ ॥
स यत्र पारसीकीययुद्धवार्त्तामचीकथत् ॥
अंशोऽसौ तत्प्रबन्धस्य विश्वास्योऽस्तीत्यमब्रुवं ॥ ५४६ ॥
ग्रन्थादौ पारसीकादिदेशीयानां महीक्षितां ॥
चरितं कथ्यते प्रत्नमिति पूर्वमवादिषं ॥ ५४७ ॥
विदेशान् पारसीकादीन् हेरदत्तः परिव्रजन् ॥
यत्नात् तत्तत्पुरावृत्तमप्राक्षीदिति चाब्रुवं ॥ ५४८ ॥
स यत् त्वेवं पुरावृत्तं विदेशीयं समग्रहीत् ॥
तत् प्रत्नत्वादिहेतुभ्यः सुविश्वास्यं न बुध्यते ॥ ५४९ ॥
तत्तद्देशीयलोकानां मुखाद् याः प्राक्तनीः कथाः ॥
सोऽश्रौषीत् ता यथायोग्यं विनिश्चेतुं स नाशकत् ॥ ५५० ॥
यतस्तेषु विदेशेषु चिरकालं स नावसत् ॥
सम्यक् तत्रत्यलोकानां विशेषान् न विवेद च ॥ ५५१ ॥
कथाश्च याः स शुश्राव तत्रत्यानां नृणां मुखात् ॥
भूयोऽतिप्रत्नवृत्तान्तविषयिण्यो भवन्ति ताः ॥ ५५२ ॥
अतः स यद् विदेशीयं पुरावृत्तमवर्णयत् ॥
तद् वृत्तानिश्चयात् प्रायः सुविश्वास्यं न विद्यते ॥ ५५३ ॥
तथा च विश्रुतो ग्रन्थो हेरदत्तकृतो बुध ॥
द्विधा विभिद्यते विज्ञैः प्रत्नवृत्तान्तवेदिभिः ॥ ५५४ ॥
स्वकालिकस्य युद्धस्य यं वृत्तान्तमसौ सुधीः ॥

स्वग्रन्थे वर्णयामास तं विश्वास्यं विदुर्बुधाः ॥ ५५५ ॥
परन्त्वसौ विदेशीयं यच्चरित्रमचीकथत् ॥
तादृक्षं तत्र विश्वासं न कुर्वन्ति मनीषिणः ॥ ५५६ ॥
विदेशपूर्ववृत्तान्तं सद्विवक्षुः स सन्नपि ॥
निश्चेतुं नाशकत् सम्यगिति विद्वज्जना विदुः ॥ ५५७ ॥
येनैतं विषयं सम्यक् स्फुटीकुर्य्यां महाशय ॥
तदर्थमत्र दृष्टान्तमन्यं वक्ष्यामि सम्प्रति ॥ ५५८ ॥
आसीत् प्लूतार्खनामाऽन्यः प्रसिद्धो यवनः सुधीः ॥
नानाप्रस्तावसम्बन्धिग्रन्थकारो मनोहरः ॥ ५५९ ॥
तत्कालादद्यपर्यन्तं प्रायः सप्तशताधिकं ॥
सहस्रमेकमब्दानां व्यतीयायेति निश्चितं ॥ ५६० ॥
स्वस्मात् प्राचां स रौम्याणां यवनानाञ्च भूभृतां ॥
सेनान्यां पण्डितानाञ्च चरित्राणि प्रणीतवान् ॥ ५६१ ॥
येषां मह्रीच्छिदादीनां स वृत्तान्तमवर्णयत् ॥
तेषां केचित् सहस्राब्दं तस्मात् पूर्वमवित्सत ॥ ५६२ ॥
तन्मध्ये भूरयोऽन्ये तु ग्रन्थकर्त्तुरनेहसः ॥
अल्पेन व्यवधानेन पूर्वं भूमावजीविषुः ॥ ५६३ ॥
ये राजानोऽचिरात् पूर्वं ग्रन्थकारादवित्सत ॥
सम्यक् तदीयवृत्तानि स निश्चेतुमकल्पत ॥ ५६४ ॥
पूर्वं हि सूरयो राज्ञाममीषां समकालिकाः ॥
नाना तदीयवृत्तानि ग्रन्थबद्धान्यकुर्वत ॥ ५६५ ॥

येषां त्वसौ कथां राज्ञां सुप्रत्नानामचीकथत् ॥
अमीषां तात्त्विकीं वार्त्तां निर्णेतुं न शशाक सः ॥ ५६६ ॥
अमी हि प्राक्तना भूपा यस्मिन्नासन्ननेहसि ॥
तदा नासीद् बुधः कोपि ग्रन्थकर्त्तृत्वपेशलः ॥ ५६७ ॥
पश्चात् कविस्तु चेत् कोऽपि तच्चरित्रमकीर्त्तयत् ॥
तर्ह्यत्युक्त्याऽनृतं भूरि काव्ये स्वस्मिन्नकल्पयत् ॥ ५६८ ॥
भूभृच्चरित्रवादीनि काव्यान्येतादृशानि च ॥
सुदीर्घानेहसं यावत् ग्रन्थबद्धानि नाभवन् ॥ ५६९ ॥
तत्प्रत्नभूभृदाख्यानं स सूताख्यो यदाऽकरोत् ॥
तदानीं कविताभ्योऽन्यो नासीत् तच्चरिताकरः ॥ ५७० ॥
अतो यत् प्रत्नभूपानां चरित्रं कवितोद्धृतं ॥
सूताख्यो रचयामास तद् विश्वास्यं न मन्यते ॥ ५७१ ॥
तथा च का पुरावृत्तकथा विश्वासमर्हति ॥
का नार्हतीति ते विद्वन् यथामत्यहमुक्तवान् ॥ ५७२ ॥

अथैवं शब्दप्रमाणाङ्गस्याप्तगुणत्रयस्य निरूपणं परिसमाप्यानुमानशब्दयोः कार्यविनियोगे वाक्यव्यवहारस्यापेक्षिततया व्याकरणप्रतिपाद्यं वाक्यस्वरूपमाह ॥

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उद्देश्यविधेयसम्बन्धबोधपरत्वात् प्रतिज्ञारूपस्तत्त्वदेशीयभाषात्मको ध्वनिविशेषो वाक्यम् ॥ ५३ ॥

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।१। ननु प्रश्नोऽनुज्ञा प्रतिज्ञाचेति त्रेधा वाक्यं तत् कथमुच्यते तिज्ञारूप इति तन्न प्रश्नानुज्ञयोः प्रतिज्ञायामन्तर्भावात् यथा यूयं किमर्थमागता इत्यादिः प्रश्नो भवतामागमनकारणं ज्ञातुमह-मिच्छामीति प्रतिज्ञया तुल्यार्थः एवं यूयं गच्छतेत्यनुज्ञापि भवतां गमनमहमिच्छामीतिप्रतिज्ञया तुल्यार्थैवेति ॥

।२। तदेवं सर्वाणि वाक्यान्युद्देश्यविधेयसम्बन्धपरत्वात् प्रति-ज्ञारूपाणि तेषां कुक्षौ वर्तमानानां पदानां तु कार्यविचित्रत्व-न्नाम वैचित्र्यं तथाहि कानिचित् पदान्यु निर्देश्यबोधका कानि-चिद्विधेयबोधकानि कानिचित् तु तदुभयसम्बन्धबोधकान्यन्यानि पदवाक्यार्थसमुच्चयबोधकानि कानिचित् स्वयं वाक्यस्वरूपाणीति एतदेवकार्यवैचित्र्यं पदानां नामवैचित्र्ये कारणमित्याह ॥

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कार्यानुसारीणि पदानां नामानि भवन्ति ॥ ५४ ॥

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।१। अथ येन कार्येण यन्नाम पदानां व्यवह्रियते तत् प्रदर्श्यते ॥

।२। यत् पदमुद्देश्यबोधकं विधेयबोधकं वा विवक्षावशाद् भवितुमर्हति सा सञ्ज्ञा । गौर्डित्थ इत्यादिः ॥

।३। यत् पदं विधेयबोधकमुद्देश्यैकदेशबोधकं वा विवक्षाव-शाद् भवितुमर्हति तदुपसर्जनम् । शुक्लाश्वल इत्यादि ॥

।४। यत् पदं यथाविवक्षमुद्देश्यबोधकं विधेयबोधकं वा भवितुमर्हति परन्तु यस्यार्थो वक्तृभेदाद्भिद्यते तत् सर्वनाम । त्वमहं पर्वो दक्षिण उत्तरोऽधर इत्यादि ॥

।५। यत् पदं विधेयोद्देश्ययोः सम्बन्धं विधेयं च बोधयति तत् क्रियापदम् । स्वपिति गच्छति तिष्ठतीत्यादि ॥

।६। इतराणि पदान्यव्ययानि भवन्ति तानि च त्रेधा । समुच्चायकानि क्रियाविशेषणानि वाक्यरूपाणि चेति । तत्र पदवाक्यार्थसमुच्चायकानि चादीनि । क्रियविशेषणानि मन्दं सहासमित्यादीनि । स्वतो विस्मयहर्षविषादादिबोधकत्वाद्वाक्यरूपाणि अहहहन्तहाप्रभृतीनि ॥

।७। अथ भाषाया आरम्भस्थानमाह ॥

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वाक्यरूपाव्ययं भाषामूलम् ॥ ५५ ॥

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विस्मयहर्षविषादादिबोधकत्वात् स्वतोवाक्यरूपमव्ययं हाकारादिकमुदाहृतं तदेव भाषाया मूलमारम्भस्थानमित्यर्थः । तथाहि यदा स्तनन्धयत्वाद्भाषणासमर्थः सुस्थो बालकः क्षुधापीडितस्सन् स्वभावतो रोदिति तदा तस्य जननी तद्रोदनं क्षुधाचिन्हमिति ज्ञात्वा तं दुग्धं पाययति । इदमेव रोदनम्भाषायाः प्रथमतरः प्रकारो भवति । हाकाराहूंकाराद्यव्ययसमुदायरूपत्वात् । अत्रेच्छाविषयस्यैकत्वाद्विषयावगमे भ्रमो न भवति परन्तु यत्रानेकविषयिणीच्छास्ति तत्र विषयनिर्णयः केवलं रोदनेन न भवति । यथा स्तनन्धयात्किञ्चिदधिकवया बालकः पदार्थार्थी यदा रोदिति तदा रोदनेन तदीयेच्छाविषयनिर्णयो न

भवति परन्तु अयङ्किञ्चिदिच्छतीत्येतावन्मात्रं ज्ञायते । अतएव स यदापेयमिच्छति तदा खाद्यं यदा खाद्यं तदा पेयं तस्य जननी तस्मै ददातीत्यवस्थायां मन्माता मदिच्छाविषयो न निर्णीत इति सञ्चिन्त्येष्टं वस्तु हस्तनेत्रादिना सूचयति । अत्र यत् सूचितं वस्तु तद्वाक्यस्योद्देश्यमिच्छाच विधेयं भवति । पश्वादयो ऽप्येवमेव भाषणं कर्तुं समर्थाः । यथा कश्चिच्छ्वा कस्यचिद्धस्त मांसखण्डं दृष्ट्वा लाङ्गूलञ्चालयन्मन्दं शब्दायते तदा तस्येच्छा तद्विषयश्चेति द्वयमपि ज्ञायते । इयांस्तु विशेषो यदेतावत्सङ्केतादधिकं पश्वादयः किमपि न कुर्वन्ति मनुष्यस्तु तदधिकं कर्तुं समर्थ इति । तथाच पश्वादिविषये भाषाया आरम्भमात्रं मनुष्यविषयेत तस्याः क्रमेण वृद्धिः परिष्कारश्चेति । इति समाप्तः शब्दखण्डः ॥

अथैवं प्रमाणस्वरूपं विविच्य तदधिगम्यानि निरूपयितुमिष्टानि प्रमेयाण्युद्दिशति ॥

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संख्यापरिमाणे भूगोलादिगतिर्गतिहेतुबलं रासा-
यनिकगुणा जीवद्वस्तुतत्त्वं भूगोलाभ्यन्तरवाह्यतत्त्व-
मितिहासो देशधनवृद्धिह्रासकारणं नीतिर्जगत
ईश्वरजन्यता चेत्येतानि प्रमेयाणि ॥ ५६ ॥

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अनेनैवोद्देशक्रमेणोत्तरग्रन्थ एषां निरूपणम् । तत्र चायं

हेतुः । यस्य विचारे यद्विचारनैरपेक्ष्यं तस्य तस्मात् पूर्वं निरूपणं । यस्य च विचारे यद्विचारनैरपेक्ष्यं न्यूनं तस्य तस्मात् परं निरूपणम् । यथा संख्यापरिमाणयोः सर्वद्रव्यसाधारणधर्मतया तयोर्विचारे गतिबलरासायनिकगुणादिविचारनैरपेक्ष्यमतस्ते तेभ्यः पूर्वं निरूप्येते । गतिबलादिविचारे च सङ्ख्यादिविचारसापेक्षत्वमिति तेषां ततः परं निरूपणमित्यादि ॥

इति श्रीमज्जेम्स् बालण्टैनविरचितायां न्यायकौमुद्यां प्रमाणस्वरूपपरीक्षणं नाम द्वितीयो ऽध्यायः ॥

। १ । पूर्वाध्यायान्ते प्रमेयगणे प्रथममुद्दिष्टयोः सङ्ख्यापरिमाणयोस्तत्प्रमितभूगोलादिगतेश्च विचारः करिष्यते ॥

। २ । तत्र गणितस्कन्धे निर्दिष्टसङ्ख्याविचारात्मकं शास्त्रं व्यक्तगणितमित्युच्यते ॥

। ३ । अथ सङ्ख्यायाः स्थानानां दशगुणोत्तराभिरेव सञ्ज्ञाभिर्लोके व्यवहारो न पञ्चादिगुणोत्तराभिरित्यत्र सम्भाव्यमानं बीजमाह ॥

नूनं मनुष्याणां दशाङ्गुलित्वात् सङ्ख्यास्थानसंज्ञा दशगुणोत्तरा एव ॥ १ ॥

। १ । मनुष्यादिसमूहं दृष्ट्वा तद्गतव्यक्ति सङ्ख्यां जिज्ञासमानो लोक एकैकां व्यक्तिमेकैकयाङ्गुल्या गणयति दशव्यक्तीर्दशभिरङ्गुलीभिर्गणयित्वा पुनरेनमेवप्रकारमावर्त्तयति तादृशदशावृत्तिसङ्ख्यानिश्चयायान्यः कश्चित् ता आवृत्तीः स्वाङ्गुलीभिर्गणयति । एवं तस्याप्यन्यस्तस्याप्यन्य इति । अतस्तर्क्यते दशाङ्गुलिसत्वं सङ्ख्यास्थानसंज्ञानां दशगुणोत्तरत्वव्यवहारे बीजमिति । यदि हि मनुष्यस्य द्वादशाङ्गुलयोऽभविष्यंस्तर्हि सङ्ख्यास्थानसञ्ज्ञानां द्वादशगुणोत्तरत्वमभविष्यदिति ॥

। २ । व्यक्तगणितसम्बन्धिनो विधयो बापूदेवकृतगणितप्रकारणादवगन्तव्याः ॥

। ३ । तत्र यदातिमहत्योः सङ्ख्ययोर्गुणनं भजनं वा विधेयं तदा प्रसिद्धरीत्या तत्सम्पादने महागौरवं क्लेशश्च भवति । अतस्तयोः सङ्ख्ययोः स्थाने घातप्रमापकसंज्ञके अन्येसङ्ख्ये कल्प्येत तद्द्वारा च फलमल्पक्लेशेन लघुप्रकारेण ज्ञायत इत्याशयेनाह ॥

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घातप्रमापकसङ्ख्यानामुपादाने कृते योगान्तराभ्यां
गुणनभजनफले सिद्ध्यतः । तथा गुणनभजनमा-
नेण घाततन्मूले सिद्ध्यतः ॥ २ ॥

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। १ । तथाहि । यत्रोत्तरोत्तरमैकयैव सङ्ख्ययाधिकाः सङ्ख्या वर्त्तन्ते यत्र चाद्यसङ्ख्या चयतुल्या स्यात तादृश्येका सङ्ख्यानां श्रेणी

कल्प्या । यथा । १ । २ । ३ । ४ । ५ । इत्यादि । अत्र चयः । १ । ततो द्वितीयैका सङ्ख्यानां श्रेणी तथा कल्प्या यथा तत्र सङ्ख्या उत्तरोत्तरं दिच्यादिगुणाः स्युर्यत्र चाद्यसङ्ख्या गुणतुल्या स्यात् । यथा । १० । १०० । १००० । १ ०००० । इत्यादि । अथेयं प्रथमश्रेण्या अधस्तात् क्रमेण लेख्या ।

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|---|---|---|---|---|
| १ | २ | ३ | ४ | ५ |
| १० | १०० | १००० | १०००० | १००००० |
| ६ | ७ | ८ | | |
| १०००००० | १००००००० | १०००००००० | | |

तत्रोर्ध्वपङ्क्तिस्थाः सङ्ख्याः क्रमेणाधःस्थितसङ्ख्यानां घातप्रमापकसंज्ञाः स्युः । तासां च योगादिभ्यो गुणनफलादिकं सिद्ध्यति । तथाहि ॥

। २ । ऊर्ध्वपङ्क्त्यां द्वयोः सङ्ख्ययोर्योगो यः स्यात् तदधस्ताद्द्वितीयपङ्क्त्यां स्थिता सङ्ख्या द्वितीयपङ्क्तिस्थयोस्तयो र्व्ययोजकाधरसङ्ख्यायोर्बधेन समा भवतीति । यथा । ऊर्ध्वपंक्त्यां । २ । ४ । अनयोर्योगः । ६ । एतदधो द्वितीयपङ्क्त्यां वर्त्तमाना । १०००००० । इयं सङ्ख्या । २ । ४ । एतदधरयोर्द्वितीय पङ्क्तिस्थयोः । ०० । १०००० । अनयोः सङ्ख्ययोर्बधेन सामाना ॥

। ३ । एवमेवोपरितनपङ्क्त्यां सङ्ख्ययोरन्तरं यत् स्यात् तदधस्ताद्द्वितीयपङ्क्त्यां स्थिता सङ्ख्या द्वितीयपङ्क्तिस्थयोः तद्वि-

योज्यवियोजकाधरसङ्ख्ययोःलब्ध्यासमा भवति। यथा । ६ । ४ । अनयोरन्तरम् । २ । एतदधोऽधरपङ्क्त्यां स्थिता । १०० । इयं सङ्ख्या । ६ । ४ एतदधरयोः द्वितीयपङ्क्तिस्थयोः । १००००००। । १०००० । अनयोः सङ्ख्ययोर्लब्ध्या समा भवतीति ॥

। ४ । एवमेवोपरितनी सङ्ख्या द्व्याद्यैर्गुणिता भक्ता वोर्ध्वपङ्क्त्यां या भवेत् तदधःस्था सङ्ख्या तदुपरितनसङ्ख्याधःस्थसङ्ख्याया द्व्यादिसङ्ख्यापूर्वको घातो द्व्यादिसङ्ख्यापूर्वकघातमूलं वा स्यात् । यथोर्ध्वपङ्क्त्यां । २ । इयं त्रिभिर्गुणिता । ६ । एतदधःस्था । १००००००। इयं सङ्ख्या । २ । एतदधःस्थाया ।१०० । अस्या घनो भवतीति । एवं गणितलाघवाय सङ्ख्यामात्रस्य घातप्रमापकाणामल्पायासेन लाभार्थमेकाद्ययुतान्तसङ्ख्यानां घातप्रमापकबोधिकाः सारण्यो लिखिताः सन्ति । अथ गणितशास्त्रे तत्तच्चिन्हव्यवहारे बीजमाह ॥

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## गणितीयक्रियाबोधलाघवार्थं चिन्हव्यवहारः ॥ ३ ॥

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। १ । चिन्हव्यवहार इति । गणिते लाघवार्थमनेकानि चिन्हानि व्यवह्रियन्ते । सङ्ख्ययोर्मध्ये लिखितं (+) इदं चिन्हं तत्सङ्कलनज्ञापकं स्यात् । यथा २ + ४ इत्येतेन द्विचतुर्योगो ज्ञाप्यते ॥

। २ । तिर्यक् समान्तररेखाद्वयं समत्वबोधकं स्यात् । यथा

२ + ४=६ इत्यत्र द्विचतुर्योगफलं षड्भिः सममिति बुध्यते ॥

।३। सङ्ख्ययोर्मध्ये (=) एवं तिर्यग्रेखाद्याया द्वितीया शोध्येति द्योतयति। यथा ६—२=४ इत्यनेन षड्भ्यो द्वयोः शोधितयोः शेषं चतुर्भिः सममिति द्योत्यते । अपि च षड्भ्यो द्वयस्यैव वर्जनेन चत्वारः शिष्यन्ते नान्यसङ्ख्यावर्जनेनेत्यतोऽयं धर्मो द्वयस्यैव न सङ्ख्यामात्रस्य परन्तु कतिचिद्धर्माः सर्वसङ्ख्यासाधारणा भवन्ति। यथा द्वौ पञ्चचानयोर्योगः सप्त । ७ । अन्तरं च यत्रम् । ३ । तयोर्योगो दश सचोक्तसङ्ख्ययोर्महत्या द्विगुणो भवति । एवं तयोरन्तरं चतुष्कं तच्चाल्पसङ्ख्याया द्विगुणं भवति । इत्थं सर्वत्र विद्यात् ॥

।४। अतएवाज्ञातसङ्ख्याकयोर्वस्तवद्बमुद्रासञ्चययोरन्तरेण सहितो योगो बहुमुद्रासञ्चयाद्विगुणो भवतीति निश्चीयते ॥

।५। अथ बहुमुद्रासञ्चयश्चेत् (अ) कारेण द्योत्यते अल्पमुद्रासञ्चयश्च (क) कारेण तदेदं समीकरणद्वयमुत्पद्यते ॥

$$(अ+क)+(अ-क)=२अ$$

$$(अ+क)=(अ=क)=२क$$

अत्र अ क अनयोरिष्टसङ्ख्याभ्यामुत्थापितयोरपिपक्षयोः साम्याविघात एव स्यात् ॥

।६। एवमज्ञातसङ्ख्यानां तदवगमकविधिप्रयोगाय य ईदृशो वर्णव्यवहारः स बीजगणितसञ्ज्ञको भवेत् ॥

। ७ । अथ व्यक्तबीजगणितयोः स्वरूप इव फलेऽपि वैलक्षण्यमस्तीत्याशयेनाह ॥

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बीजक्रियया निष्पद्यमानं फलं सामान्यधर्मेण
सिद्ध्यति न तु विशेषधर्मेण ॥ ४ ॥

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। १ । अत्र पूर्वोक्तचिन्हेभ्योऽन्यान्यपि क्रियाद्योतकचिन्हानि व्यवह्रियन्ते । तथाहि सङ्ख्ययोर्मध्ये लिखितं (+) इदं चिह्नं तयोर्वधं द्योतयति । यथा अ+क इदं अकारद्योत्यसङ्ख्या ककारद्योत्यसङ्ख्यया गुणनीयेति द्योतयति । एवं चिन्हेनाव्यवहितौ सन्निहितवर्णावपि स्ववधं द्योतयतः । यथा (अक) अत्र चेत् अ=२ क=३ तदा अक=६ ॥

। २ । एवमेकवर्णस्याधो रेखां कृत्वा तदधस्तादपरवर्णे लिखिते यत् सम्पद्यते तदुपरितनवर्णद्योत्यसङ्ख्याया अधस्तनवर्णद्योत्यसङ्ख्यया लब्धं द्योतयति । यथा यदि अ=६ क=२ $\frac{\text{अ}}{\text{क}}$=३ ॥

। ३ । अ वर्णेन द्योत्यायाः सङ्ख्याया वर्गः अ$^{२}$ एवं लिख्यते घनश्च अ$^{३}$ एवं लिख्यते । एवं सर्वत्र । एष च सङ्ख्याद्योतकवर्णोपरि लिखितो ऽल्पो ऽङ्को घातमापकपदेन व्यवह्रियते ॥

किञ्च

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बीजक्रियया सम्पन्नानां फलानां सर्वसङ्ख्यासाधा-

रणत्वात् तान्येव व्यक्ते सूत्रत्वेन परिणमन्ते ॥ ५ ॥

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। १ । उदाहरणम् । यासु चतसृषु सङ्ख्यासु द्वितीया प्रथमायास्तावद्वारं शुद्ध्यति यावद्वारं चतुर्थी तृतीयायाः शुद्ध्येत् ताश्चतस्रो ऽनुपातस्था स्युः । यथा (अ।क।ग।घ) एतासु चतसृषु यदि (अ) अस्याः (क) इयं तावद्वारं शुद्ध्यति यावद्वारं ग यस्याः घ इयं शुद्ध्येत् तर्ह्येता अनुपातस्थाः स्युः । कल्प्यतां तावत् (अ) अस्या (क) इयं त्रिवारं शुद्ध्यति तदा $\frac{अ}{क}=३$ । $\frac{ग}{घ}=३$ । अथ प्रत्येकमेकेनैव केनचित् समानानां सर्वेषां मिथः समानत्वात् $\frac{अ}{क}=\frac{ग}{घ}$

। २ । अथच समयोः समगुणने समत्वाविघातात् (क+घ) अनेन पूर्वसमीकरणपक्षयोर्गुणितयोः सिद्धम् (अघ=कग) । अनेनानुपातस्थेषु चतुर्षु राशिषु प्रथमचतुर्थयोर्वधो द्वितीयतृतीयवधेन समानो भवतीति ज्ञायते । इद मेवमहोपकारस्य त्रैराशिकव्यस्तकाख्यगणितस्य बीजम् । त्रैराशिके ऽनुपातस्थांस्त्रीन् राशीन् निर्दिश्य चतुर्थो जिज्ञास्यते । तदा प्रश्नालापानुसारेण त्रीन् राशीन् यथास्थानं विन्यस्य द्वितीयतृतीययोर्वधः क्रियते । स प्रथमचतुर्थयोर्वधेन तुल्य इति चतुर्थराशेरवगमाय स वधः प्रथमेन ह्रियते ॥

। ३ । अथ बीजगणितोत्तरं क्षेत्रमितिं निरूपयितुमंशतस्तस्या बीजगणितसाध्यत्वमाह ॥

क्षेत्रमिति विषया बीजगणितमन्तरेण नैव
ज्ञायन्ते ॥ ६ ॥

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। १ । तद्यथा । यद्यङ्गुलमिता रेखा एकसञ्ज्ञिका कल्प्येत तर्हि अङ्गुलद्वयमिता द्विसञ्ज्ञिकास्यात् । अष्टाङ्गुलपरिमिताऽष्टसञ्ज्ञा स्यात् । अपिच या सङ्ख्या अङ्कारेण ज्ञाप्यते तन्मिता रेखापि अङ्कारेण द्योत्या स्यात् । तथा वर्गक्षेत्राणि घनक्षेत्राणि च वर्णैर्ज्ञापयितुं शक्यन्ते । ततो बीजगणितक्रियया तद्वर्तिगुणा आविर्भवन्ति ॥

। २ । केचित् पुनस्तुल्यद्विबाहुकत्रिभुजस्य भुलग्नकोणयोर्मिथः सम्बन्धाद्या आकारस्यानेके गुणा न कदाचिदप्यङ्कैर्ज्ञापयितुं शक्यन्ते किन्तु सरलरेखाभिर्वक्ररेखाभिर्वा । रेखादिविषयिणी च विद्या क्षेत्रमितिसञ्ज्ञिका स्यात् । तत्रादौ सरलवक्ररेखे लक्षयति ॥

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यस्यां सर्वे बिन्दवः प्रथमबिन्दुसमानदिक्काः सा सरला । यस्याश्चातिसूक्ष्मोऽप्यवयवो न सरलः सा वक्रा ॥ ७ ॥

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। १ । अतः सरलवक्ररेखयोर्बिन्द्वोरेकत्रस्थितयोस्तदव्यवहितोत्तरबिन्दू न कदाचिदेकत्र स्यातुं शक्नुतः । तत्र सरला

रेखैकविधैव वक्ररेखाणां तु नानाविधत्वेऽपि युक्लीद् सञ्ज्ञकस्य क्षेत्रमित्यां श्रीबापूदेवशास्त्रिणा संस्कृतेन रचितायां वृत्तपरिधिरूपिण्यैकैव वक्रा रेखा व्यवहृता नान्या ॥

। २ । अथ ये क्षेत्रे मिथः संयुक्ते सर्वावयवावच्छेदेन परस्परं मिलतस्ते मिथः समाने इति युक्लीदाख्यस्याधिकरणसिद्धान्तः । एतन्मूलकएवच तस्यायं प्रथमाध्याये चतुर्थसिद्धान्तः ययोस्त्रिभुजयोरेकस्य भुजद्वयतदन्तर्गतकोणौ क्रमेणापरस्य भुजद्वयतदन्तर्गतकोणाभ्यां समानौ ते मिथः समाने इति तयोस्त्रिभुजयोर्मिथः संयोजितयोस्सर्वतो मिलनादिति ॥

। ३ । अत्रेयमनुपपत्तिः । यतः सरलवक्ररेखयोर्बिन्दोरेकत्रस्थितयोस्तदव्यवहितोत्तरबिन्दू न कदाचिदेकत्र स्थातुं शक्नुत इत्युक्तमतो यस्य क्षेत्रस्य मर्यादा वक्राः सन्ति यस्यच सरलास्तयोः परस्परं सर्वतो मेलनं न केनचिदपि विभागकल्पनेन सम्भवतीति तादृशक्षेत्रयोः साम्यनिर्णयो दुर्घट इति ॥

। ४ । अस्याश्च निरासाय युक्लिदाख्यस्य कालादारभ्य न्यूटनाख्यस्य कालपर्यन्तमतीतस्य वर्षसहस्रद्वयस्य मध्ये गणिताश्रितज्यौतिषादिविद्यादृष्ट्युपयोगिनो वक्ररेखावृतक्षेत्राणां सरलरेखावृतक्षेत्रैः साम्यविधानस्यानेके प्रकाराः कल्पितास्तेषुमध्ये योऽयं लैब्निसाख्यस्य जेर्मणीदेशीयमहाज्ञानिनो लेखनप्रकारेण परिष्कृतो ऽपरेषां प्रकाराणां लोपस्य कारणभूतो न्यूटणाख्यस्य प्रकारः स वैलक्षण्यपूरितगणितसञ्ज्ञकः स्यात् ॥

। ५ । यथा स्तम्भोपरि स्थितो मयूरः स्तम्भतले स्थितं बिलमागच्छन्तं सर्पं स्तम्भात् किञ्चिदन्तरे दृष्ट्वा तद्ग्रहार्थं तदुपर्यपतत् । तत्र स्तम्भस्योच्चत्वं बिलसर्पान्तरं च निर्दिष्टम् । सर्पमयूरयोः समकालगमनांशप्रमाणे च निर्दिष्टे । तथाच स मयूरो बिलात् कियत्यन्तरे सर्पं जग्राहेत्यस्य प्रश्नस्योत्तरं वैलक्षणगणितमन्तरेण न सिद्ध्येत् । मयूरस्य गमनमार्गो हि प्रतिक्षणं भिन्नदिक्कोऽतश्च वक्ररेखारूपः । सा च वक्ररेखा यैरुपायैर्निश्चीयते ते केवलं वैलक्षणगणितज्ञेनैव ज्ञातुं शक्यन्ते । यत्तु भास्कराचार्यैर्लीलावत्यां मयूरस्य यावत्सर्पसंयोगं सरलरेखायां गतिं मत्वा तदनुसारेण फलमानीतं तन्मयूरस्य स्वसर्पसंयोगस्थानं पूर्वं ज्ञातुं सामर्थ्ये सति घटेत नत्वन्यथेति ॥

। ६ । अथ वैलक्षणगणितस्य मध्यमबीजज्ञेयमेकं सुगममुदाहरणं प्रदर्श्यते ॥

। ७ । उच्चप्रदेशात् पतन् पदार्थः प्रथमेऽसुपादे पादोनैकादशहस्तमितदेशमतिक्रामति । द्वयोरसुपादयोस्ततश्चतुर्गुणं । त्रिष्वसुपादेषु नवगुणमेवमग्रेऽपि । एवं पतत्पदार्थातिक्रान्तप्रदेशः कालवर्गमितो भवति । एवञ्चाल्पतमेऽपि काले पतनवेगः समानो न भवति । अन्यथा बहुकाले बह्वन्तर वेगस्य कथं स्यात् । यस्मिन्निष्टकाल इष्टसमानगत्यातिक्रान्तं कञ्चन प्रदेशं कल्पयित्वा तदनुसारेणाग्रेऽपि गमनवेगं गणयन्तीति संप्र-

दाय: सोऽत्र न सम्भवति । यत: पतत्पदार्थस्यासुतृतीयादि-चरणान्ते संजातो वेगोऽवश्यं तत्पूर्वासुपादजातवेगादधिको भवेत् तदुत्तरासुपादजातवेगान्न्यून: स्यात् तथाच तृतीयाद्यसु-पादान्ते पतत्पदार्थे कियान् वेग: स्यादित्यस्य प्रश्नस्योत्तरं ज्ञातुं न्यूटनाख्यकृते बाह्यप्रपञ्चविचारे प्रथमं प्रदर्शितस्योपसिद्धान्तस्य ज्ञानमावश्यकमत: स प्रदर्श्यते ॥

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ययोश्चलयोराश्योरन्तरं सर्वस्मात् निर्दिष्टपरिमा-णान्न्यूनं भवितुमर्हति तावन्ते मिथ: समानौ स्या-तामिति ॥ ८ ॥

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। १ । यद्यन्ते ते मिथ: समानौ न स्यातामित्युच्येत तर्हि तयोरन्तरं अ एतावत् स्यान्नतु ततो न्यूनं तथाच सति ययोर-न्तरं सर्वस्मान्निर्दिष्टपरिमाणान्न्यूनं भवितुमर्हतीति व्याहन्येता-तस्तयोरन्ते समानत्वमुपपन्नम् । एतत्सिद्धान्तयोगेन बीज-क्रिययाचोक्तप्रश्नोत्तरं सिद्ध्यति । तथाहि ॥

पतत्पदार्थातिक्रान्त प्रदेशस्य पादोनैकादशहस्तमितो मान-दण्ड: कल्प्यतां तथाच पतत्पदार्थेन (य) असुपादैर्यावान् देशो ऽतिक्रम्यते स य$^{2}$ सङ्ख्याकमानदण्डमित: स्यात् । एवं (च) अय-मतिसूक्ष्मकालमानद्योतक: कल्प्यतां तथा ( ओ ) स्थानात् पतित: पदार्थ: ( य ) असुपादै: (अ) स्थानं प्राप्नयात् ( य+च)

असुप्रादेश्च (क) स्थानं प्राप्नुयात् (य+२च) कालेनच (ग) स्थानं गच्छेदित्यादि कल्प्यतां तदा अतिक्रान्तप्रदेशमानानि ।

ओअ = य$^{२}$ । ओक =(य+च)$^{२}$ ।

ओग =(य+२च)$^{२}$ इत्यादीनि भवन्ति

अतः (च) परिमितकालखण्डेष्वतिक्रान्ताः

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अक = ओक—ओअ = २यच+च$^{२}$ =(२य+च) च

क ग= ओग —ओक = २यच+३च$^{२}$ =(२य+३च) च

गघ = ओघ—ओग = २यच+५च$^{२}$ =(२य+५च) च

इत्यादिप्रदेशाः क्रमेण

२य+च २य+३च २य+५च इत्यादीनामनुसारेण भवन्ति । अत्र यद्यपि बहुकाले वेगस्य बह्वन्तरं स्यात् तथापि यथा यथा स्थानद्वयस्यान्तरमल्पं भवेत् तथा तथा तत्रत्यवेगयोन्तरमपचीयेत । अतो यथा यथा ( च ) कालस्याल्पत्वं स्यात् तथा तथा प्रागुक्तातिक्रान्तप्रदेशप्रमाणानि समगत्यतिक्रान्तप्रदेशप्रमाणादल्पान्तराणि भवेयुरत एवान्ते (च) अस्य शून्यतापर्यवसिते परमह्रासे तानि प्रमाणानि समगत्यतिक्रान्तप्रदेशप्रमाणेन समानानि भवेयुरिति पूर्वोक्तसिद्धान्तेन सिध्यति ॥

।२। अथ (च) अस्य शून्यत्वे तानि सर्वाणि प्रमाणानि (२य) मितानि भवेयुः । अनेन (य) असुपादान्ते पतत्पदार्थगम्यदेशः (२य) सङ्ख्याकमानदण्डमितो भवेदिति ज्ञायते ॥

। ३ । एवञ्च । असुपादत्रयान्ते पतनवेगः सार्धचतुःषष्टिहस्तमितदेशातिक्रमणानुकूलो भवेत् । यतः $२\times३\times\frac{४३}{४}=६४\frac{१}{२}$ परं वस्तुतो वर्द्धमानगतित्वात् स पदार्थः पञ्चसप्ततिहस्तान् गच्छति ॥

। ४ । अत्र (ओअ) रेखात्मको राशिः क्रमवृद्ध्या प्रतिक्षणं भिन्नत्वात् चलसञ्ज्ञः स्यात् ॥

। ५ । अस्मिन् गणिते चलराशीनां द्योतनाय । य । र । ल । इत्यादिवर्णाः सङ्केतिताः । एवं येषां योगेन चलराशेर्मानं विलक्षणं भवति येचानन्तसूक्ष्मत्वेन कल्पयितुं शक्यन्ते ते (अक) (कग) (गघ) इत्यादयः खण्डा वैलक्षण्यशब्दवाच्याः ॥

। ६ । एवं (य) (र) (ल) इत्यादीनां वैलक्षण्यस्य द्योतनाय (वैय) (वैर) (वैल) इत्यादिकं सङ्केतितम् ॥

। ७ । अथ पूर्वप्रदर्शितसमाधानः प्रश्नो वैलक्षण्यगणिते यदि (य) अस्य प्रतिक्षणविकारः सममानः स्यात् तर्हि ($य^२$) अस्य किम्मानः स्यादित्याकारको भवति तत्र च ($य^२$) अस्य विकारः (य) अस्य विकारात् (२य) एतद्गुणाधिको भवतीति प्रदर्शितं तेन यदि (य) अस्य वैलक्षण्यं (वैय) एतत् स्यात् तर्हि ($य^२$) अस्य वैलक्षण्यं (२य.वैय) इति भवेदित्युत्तरम् ॥

। ८ । अथ २य.वैय $य^२$ अनयोर्मेलनेन वैलक्षण्यज्ञापको ऽयं प्रथमो विधिरुत्पद्यते । यस्य वैलक्षण्यं ज्ञातव्यं तस्य

घातमापकं निरेकं कुर्यात् ततस्तस्मिन् घातमापकेन तत्रत्य-चलराशेर्वैलक्षण्येन च गुणिते ऽभीष्टं वैलक्षण्यं सम्पद्यते ॥

। ९ । अत्र कतिचिदुदाहरणानि प्रदर्श्यन्ते वैय.$^{३}$=३य.$^{२}$वैय एवं वैय४ = ४य.$^{३}$वैय इत्यादि ॥

। १० । अत्र वैलक्षण्यस्थो यो गुणकः स उच्यते वैलक्षण्य-प्रकृतिरिति । यथा ४य.$^{३}$वैय अत्र ४य$^{३}$. इति वैलक्षण्यप्रकृतिः स्यात् ॥

। ११ । यदा कस्यचिदस्थिरराशेर्मानमपरास्थिरराशिमा-नाधीनं स्यात् तदा स राशिरपरस्य फलमित्युच्यते ॥

। १२ । यथा । वर्गक्षेत्रस्य फलं तद्भुजाधीनमतस्तद्भुजस्य फलं भवेत् ॥

। १३ । वैलक्षण्यगणितस्य मुख्यं प्रयोजनं यस्य कस्यापि निर्दिष्टफलस्य वैलक्षण्यसाधनमेव ॥

। १४ । पूरितगणितस्य प्रयोजनं तु निर्दिष्टाद्वैलक्षण्यात् तत्फलस्यानयनम् ॥

। १५ । अत एव पूरितं पूर्वोक्तविधिविपर्यासेनोत्पद्यते ॥

। १६ । तथाहि यस्य पूरितं ज्ञातव्यं तस्य घातमापकं सैकं कुर्यात् ततस्तस्मिन् सैकघातमापकेन तत्रत्यास्थिरराशेर्वैलक्षण्येन च भक्ते ऽभीष्टं पूरितं सम्पद्यते ॥

। १७ । यथा (२य.वैय) अस्माद्वैलक्षण्यात् (य$^{२}$) इदं फलं लभ्यते ॥

। १८ । तत्र दीर्घाकारं (पू) इदं पूरितद्योतनाय सङ्केतितम् । अतः । पू.२य.वैय =य² ॥

। १९ । एवमेतत् सङ्ख्यापरिमाणविचारप्रकरणं परिसमाप्तम् । अथ क्रमप्राप्ता तत्प्रमिता भूगोलादिगतिर्विचार्यते । तत्रादौ तद्विषयकशास्त्रस्य सञ्ज्ञामाह ॥

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सङ्ख्यापरिमाणप्रमितायाः भूगोलादिगतेः प्रतिपादकं शास्त्रं ज्यौतिषमित्युच्यते ॥ ९ ॥

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। १ । अत्रादिपदेनसूर्यग्रहकेतुनक्षत्रादीनां ग्रहणम् । तत्र सूर्यो नक्षत्राणि च स्वप्रकाशानि ग्रहकेत्वादयश्च परप्रकाशास्ते सर्वे रवितेजसैव प्रकाशन्ते । अतएव यथा चन्द्रस्य कलानां वृद्धिह्रासौ भवतस्तथा शुक्रादिकलानामपि भवतः । एतत्तु दूरदर्शकयन्त्रेण ज्ञायते ॥

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भूगोलाकारः ॥ १० ॥

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। १ । प्रथमं कश्चिदापातदर्शी पुरुष इमां भुवं चतुर्दिक्ष्वधश्चानन्तां मन्यते परन्तु तेन रविचन्द्रौ नक्षत्राणि च प्रत्यहं पश्चिमतो भूमेरधो गत्वास्खलितं पूर्वत उद्गच्छन्तीति सविचारं विलोकिते भूर्नास्त्यनन्ता किन्त्वेकः परिच्छिन्नः पिण्ड आकाशे निराधारो वर्तत इत्यनुमीयते । उक्तंच भास्कराचार्यैः भप्रञ्जरस्य

भ्रमणावलोकादाधारशून्या क्षुरिति प्रतीतिरिति ॥

। २ । एवमस्याः परिच्छिन्नत्वे सिद्धे सति गोलाकारत्वं सिद्ध्यति । तथाहि । नरो भूम्यां यत्र स्थितो भचक्रं समपश्चिमगं पश्यति ध्रुवतारां च क्षितिजलग्नां पश्यति तस्मान्निरक्षप्रदेशाच्यात् स्थानात् स यथा यथोत्तरदिशं गच्छति तथा तथा भचक्रं दक्षिणतो नतमुदग्ध्रुवतारामुन्नतां चालोकयति । उक्तं च भास्कराचार्यैः निरक्षदेशे क्षितिमण्डलोपगौ ध्रुवौ नरः दक्षिणोत्तरौ । तदाश्रितं खे जलयन्त्रवत् तथा भ्रमद्भचक्रं निजमस्तकोपरि । उदग्दिशं याति यथा यथा नरस्तथा तथा खान्नतमृक्षमण्डलम् । उदग्ध्रुवं पश्यति चोन्नतं क्षितेरिति ॥

। ३ । तथा चोक्तताट्टशदर्शनस्य भूमेर्दक्षिणोत्तरपृष्ठभागस्य वृत्ताकारतां विनानुपपत्तेस्तत्र वृत्ताकारता सिद्ध्यति । अथ च यदतिरोहिते देशे स्थितेन पुंसा दूरस्थस्य गृहादेरग्रभागः पूर्वं लोक्यते ततस्तेन यथा यथा तत्समीपं गम्यते तथा तथा तस्याधरभागा लोक्यन्ते तद्भूपृष्ठस्य सर्वासु दिक्षु वृत्ताकारतायामेवोपपद्यत इति भूर्गोलाकारेति पूर्वैर्निश्चितम् ॥

। ४ । अथाकारसिद्धिप्रयोज्यसिद्धिकत्वान्मानस्य भूम्याकारसिद्ध्यनन्तरं तन्मानमाह ॥

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भूगोलः सप्तत्युत्तराष्टशतयोजनव्यासः ॥ ११ ॥

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। १ । भूगोलस्य परिधिज्ञानोपायो भास्कराचार्यैरेवं दर्शितः । कस्मिंश्चित् पुरेऽक्षांशान् ज्ञात्वा तस्मात् पुरादुत्तरतो वान्यस्मिन् पुरे ज्ञेयाः । ततस्तेषामन्तरांशैः पुरान्तरयोजनैश्चानुपातः । यद्यन्तरांशैः पुरान्तरयोजनानि लभ्यन्ते तदा चक्रांशैः किमिति फलं भूपरिधियोजनानीति । तथाचोक्तोपायमिलितोपायेनाधुनिकैरिङ्गलण्डीयज्यौतिषिकैर्भूपरिधियोजनानि पञ्चरामाद्रिनेत्रमितानि २७३५ निर्णीतानि ॥

। २ । एवं भूपरिधौ ततस्तद्व्यासे चावगते चन्द्रसूर्यादीनां खस्थपिण्डानां तत्तल्लम्बनावगतेर्दूरत्वमहत्त्वाद्यवगमः सुगमोऽतो लम्बनं निरूपयति ॥

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द्रष्टृस्थानविशेषप्रयुक्तदृश्यस्थानविशेषो लम्बनम् ॥ १२ ॥

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। १ । यथा कस्यचिदुपविष्टस्य नरस्य स्वाग्रस्थं स्थाणुमीक्षमाणस्य दृक्सूत्रं स्थाण्वग्रगतं तत्परतो वर्तमानाया उच्छ्रितभित्तेर्यस्मिं स्थाने पतेत् तस्मात् स्थानात् तस्यैवोर्ध्वस्थस्य नरस्य दृक्सूत्रमध एव पतेत् । एवं खस्थपिण्डोऽपि भूकेन्द्रस्थेन द्रष्ट्राकाशे यस्मिन् स्थाने लोक्यते तदानीं भूपृष्ठस्थेन द्रष्ट्रा खस्वस्तिकादन्यत्र वर्तमानः स पिण्डस्तस्मात् स्थानदध एव लोक्यते तदाकाशे स्थानद्वयान्तरं तस्य खस्थपिण्डस्य लम्बनमुच्यते । इदं खस्थपिण्डे खस्वस्तिकस्थे नोत्पद्यते । तस्मात् स्थानात् क्षितिजं

यावद्यथा यथा स पिण्डो नतो भवति तथा तथा लम्बनं वृद्धिमेति क्षितिजे च परमं भवति । अथ त्रिज्याग्रे भूव्यासार्धे परमलम्बनज्यया हृते पिण्डोच्छ्रितिर्लभ्यत उच्छ्रित्या वा भक्ते परमलम्बनज्या लभ्यत इति रूढेन त्रिभुजगणितेन सिद्ध्यति ॥

। २ । एवं लम्बनस्वरूपमुक्त्वादौ चन्द्रस्य परमलम्बनं कर्णं चाह ॥

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चन्द्रस्य परमं लम्बनं सप्तपञ्चाशत् कलाश्चतस्रो
विकलाः किंचिदधिकाः कर्णश्च षड्विंशतिसहस्र-
योजनमितः ॥ १३ ॥

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। १ । चन्द्रस्य भूमध्याद्योच्छ्रितिः स तस्य कर्ण इत्युच्यते । एतन्मानावगमस्तु परमलम्बनावगतेः सुशक एव । किन्तु भूकेन्द्रे द्रष्टृसंचाराभावादुक्तप्रकारेण लम्बनावगमो दुःशकः । अतः कर्णावगमायान्यथा यत्यते । तथाहि ॥

। २ । एकस्यामेव याम्योत्तररेखायामन्योन्यं विप्रकृष्टयोर्भिन्नगोलयोर्ज्ञाताक्षांशविषययोः स्थितौ नरौ याम्योत्तरवृत्तस्थस्य चन्द्रस्य नते एकदैव जानीयाताम् । तदा तयोः स्वस्वस्थानाद्भूव्यासार्धे चन्द्रावधिनी दृक्सूत्रे चैभिश्चतुर्भिर्भुजैरावृते क्षेत्रे स्वस्थानीयभूव्यासार्धयोरन्तर्गतोऽक्षांशयोगतुल्यः कोणो यौ च व्यासार्धदृक्सूत्रयोरन्तर्गतकोणौ तत्तन्नतोनसाशीति-

शतांशतुल्यौ यौ च स्वस्थानीयव्यासार्धमितौ भुजौ ते किल सर्वे ज्ञाता भवेयुः । ततस्तत्रोर्ध्वाधरकर्णज्ञानं त्रिभुजगणितेन सुगमतरम् । स ऊर्ध्वाधरकर्ण एव चन्द्रोच्छ्रितिः । एवं चन्द्रस्य भगणपूर्तिं यावत् प्रत्यहं वेधे भिन्नैवोच्छ्रितिमितिरुपलभ्यत इति भूमध्यचिन्हमभितस्ता भिन्नोच्छ्रितीः क्रमेणाङ्कयित्वा तदग्रगता रेखा कार्या सैव चन्द्रकक्षाकृतिर्दीर्घवृत्तरूपा स्फुटा स्यात् । ततोऽवगता चन्द्रस्य भूकेन्द्रान्मध्यमोच्छ्रितिः षड्विंशति-सहस्रयोजनमिता ततोऽवाप्तं मध्यमं परमलम्बनं सप्तपञ्चाशत् कलाश्चतस्रो विकलाः सावयवाः ॥ ५७′ ४. १७″ ॥

। ३ । अथ खस्थपिण्डानां मानज्ञानस्य तत्तल्लम्बनकर्ण-ज्ञानोपजीवकत्वाच्चन्द्रस्य लम्बनकर्णकथनानन्तरं मानमाह ॥

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चन्द्रगोलः सप्तत्रिंशदधिकशतद्वययोजनव्यासः ॥ १४ ॥

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। १ । चन्द्रपरमलम्बनावगमाच्चन्द्रगोलव्यासावगमः सु-गमः । तथाहि । चन्द्रलोके दृश्यमानस्य कलात्मकभूबिम्बस्य भूलोके दृश्यमानं कलात्मकं चन्द्रबिम्बं यदंशमितं स्यात् तदं-शमित एव भूगोलव्यासाच्चन्द्रगोलव्यासः स्यादिति तु स्पष्टत-रम् । तत्र चन्द्रस्य मध्यमा बिम्बकलाः सप्तांशाधिकैक-त्रिंशत् । याश्च तस्य परमलम्बनकलास्ताभिरेव द्विगुणाभिर्मितं सकलभूबिम्बं चन्द्रलोके दृश्यं स्यात् । अतो द्विगुणाभिः

परमलम्बनकलाभिर्भूव्यासो लभ्यते तदा चन्द्रबिम्बकलाभिः क इत्यनुपातेन चन्द्रगोलव्यासो भूव्यासस्य त्रिभिरेकादशांशैस्तुल्यः सिद्ध्यतीति चन्द्रपिण्डो भूपिण्डस्यैकोनपञ्चाशत्तमांशोऽस्ती-त्यवगम्यते ॥

। २ । एवं चन्द्रलम्बनकर्णमानान्युक्त्वा रवेः परमलम्बनं कर्णं चाह ॥

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रवेः परमलम्बनं किंचिदधिकाः सार्धाष्टविकलाः
कर्णश्च पञ्चलक्षोत्तरकोटियोजनमितः ॥ १५ ॥

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। १ । पूर्वं प्रदर्शितश्चन्द्रोच्छ्रितिलम्बनयोर्ज्ञापकः प्रकारो यद्यपि शुद्धस्तथाप्ययं सूर्योच्छ्रितिलम्बनावगमाय न युज्यते यतो यन्त्रवेधविधिना ज्ञातानां तस्य नतांशानां स्वल्पान्तरत्वेऽपि सूर्यस्यातिदूरत्वात् तेभ्य उक्तप्रकारेण साधितायामुच्छ्रितौ महदन्तरं भवति । अतो ज्योतिर्विदः शुक्रस्य सूर्यबिम्बाति-क्रमणकालाद्रवेर्लम्बनं साधयन्ति । तदित्थम् ॥

। २ । यदा शुक्रः स्वल्पशरो नीचासन्नः स्यात् तदा तन्मू-र्तिः सूर्यबिम्बे श्यामवर्णा लोकैर्लोक्यते तदानीं यो भूव्यासः क्रान्तिवृत्तचेत्रे लम्बरूपः स्यात् तदग्रस्थिताभ्यां द्रष्टृभ्यां युगप-च्छुक्रबिम्बे विलोकित एको द्रष्टा सूर्यबिम्बे शुक्रचिन्हं यत्र प-श्येन्न तत्रापरः किन्तु स शुक्रचिन्हं सूर्यबिम्ब एवान्यत्र प-श्येत् । अथ सूर्यबिम्बे शुक्रचिन्हद्वयान्तरप्रदेशो भूशुक्रान्तरेण

भूव्यासो लभ्यते तदा शुक्रसूर्यान्तरेण किमित्यनुपातेन लब्धः स्यादतः स भूशुक्रान्तरमपेक्ष्य सूर्यशुक्रान्तरस्य सार्धद्विगुणत्वाद्भूव्यासतः सार्धद्विगुणः स्याद्भूव्यासार्धतश्च पञ्चगुणः स्यात्। अस्मादिदमवगम्यते। सूर्यबिम्बे यत्कलामितमुक्तचिन्हद्वयान्तरमुपलभ्येत तत्पञ्चमांशकलामितं भूबिम्बार्धं खे सूर्यस्थो द्रष्टा पश्येत्। इदमेव सूर्यस्य परमं लम्बनमतः शुक्रचिन्हद्वयान्तरकलानां पञ्चमांशो रवेः परमं लम्बनं सूक्ष्मं स्यादतः प्रथमं शुक्रचिन्हद्वयान्तरकलासाधनप्रकारः प्रदर्श्यते। तथाहि। उक्तद्रष्टृभ्यां शुक्रकेन्द्रस्य सूर्यबिम्बप्रवेशानन्तरं यावता कालेन निर्गमो दृष्टः स्यात् तं निजनिजकालमतिसावधानतया विज्ञाय रवेः स्फुटगतिं शुक्रस्य वक्रगतिं च साधयित्वा स्वस्वकालसम्बन्धी रविशुक्रगतियोगेनातिक्रान्तः प्रदेशः कलात्मकः साध्यः। स स प्रदेशो रविबिम्बे पूर्णज्यारूपः स्यात्। अथ कलात्मकं सूर्यबिम्बं तु ज्ञातमेवास्ति। ततस्तयोः पूर्णज्ययोः शरौ ज्ञात्वा तयोरन्तरे कृते यावत्यः कलाः सम्पद्यन्ते तावत्यस्तयोः पूर्णज्ययोर्मिथो विप्रकर्षः। ता एव शुक्रचिन्हद्वयान्तरकलाः। एवं चिन्हद्वयान्तरमवगम्य तत्पञ्चमांशे गृहीते लभ्यते रवेः परमलम्बनं सूक्ष्ममष्टौ विकलाः सावयवाः। ८।५७७६। अनेन प्रकारेण चन्द्रस्यापि तत्कृततारासर्वग्रसनकालज्ञानात् सूक्ष्मं परमलम्बनमवगन्तुं शक्यते। ततो रविलम्बनादुक्तप्रकारेण रविकर्णावगमः सुगमतमः॥

। ३ । अथ यस्मादेतावत्यतिदूरे वर्तमानाद्भानोर्भूस्थजनैर्महत्युष्णतालोकश्च प्राप्यते स कियन्मानः स्यादिति जिज्ञासायां भानुगोलविस्तृतिमाह ॥

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भानुगोलः सप्तनवतिसहस्रयोजनव्यासः ॥ १६ ॥

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। १ । बिम्बमापकयन्त्रेण रवेर्मध्यमा बिम्बमानकला विंशांशाधिकद्वात्रिंशन्मिता उपलभ्यन्ते । अथ यद्द्रव्यं पञ्चलक्षोत्तरकोटियोजनान्तरे वर्तमानं विंशांशाधिकद्वात्रिंशत्कलामितं दृश्यते तदवश्यं सप्तनवतिसहस्रयोजनविस्तारं भवेदिति सुगमेन त्रिभुजगणितेन सिद्ध्यतीति प्रोक्तभानुगोलव्यास उपपन्नः । अतः सकलभानुपिण्डो भूपिण्डाच्चतुर्दशलक्षगुणो महानस्तीत्याधुनिकैर्ज्योतिर्विद्वर्यैर्निर्णीतम् ॥

। २ । अथ द्रष्टुर्भूव्यासतुल्यस्थानविशेषेण यथा चन्द्रसूर्ययोः स्थानविशेषो लक्ष्यते न तथा तावता विशेषेण नक्षत्रमात्रस्य । अतो यदि भूः सूर्यं परितो भ्रमन्ती स्यात् तर्हि सूर्योच्छ्रितेर्द्विगुणस्य भूकक्षाव्यासस्यैकविंशतिप्रयुतयोजनमितस्य महत्त्वात् तत्तुल्येन द्रष्टुः स्थानविशेषेण नक्षत्राणां स्थानविशेषोपलब्धिसम्भवः स्यादित्यतः प्रथमं भूभ्रमसिद्धान्तमाह ॥

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भूगोल एकेनाहोरात्रेण स्वाक्षमभितो भ्रमन् वर्षेणैकेन रविं परितो भ्रमति ॥ १७ ॥

। १ । रव्यादयो नक्षत्राणि च भुवं परितः प्रत्यहं भ्रमन्तीति लोकानां प्रतीतिस्तु चलन्नौस्थबालानां तीरचलनप्रतीतिवद्भ्रमरूपैव । तथा चोक्तमार्यभट्टेन ॥

अनुलोमगतिर्नौस्थः
पश्यत्यचलं विलोमगं यद्वत् ॥
अचलानि भानि तद्वत्
समपश्चिमगानि लङ्कायाम् ॥ इति ॥

। २ । तत्र यद्यपि सूर्यभ्रमणेन तस्य राश्यन्तरोपलब्धिप्रयुक्तवर्षसम्पत्तिर्भवेत् तथापि पृथिव्येव रविं परितो भ्रमतीति गतिविद्ययोपपद्यते । तदुपपत्तिश्चगतिविद्याप्रकरणेप्रदर्शयिष्यते ॥

। ३ । एवं भुवः सूर्यमभितो भ्रमणे सिद्धे बुधशुक्राद्या ग्रहाः कं परितो भ्रमन्तीत्याकाङ्क्षायामाह ॥

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## एवं ग्रहा अपि रविं परित एव भ्रमन्ति ॥ १८ ॥

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। १ । यथा भूः सूर्यमभितो भ्रमति तथा बुधशुक्रादयोऽपि तमभितो भ्रमन्ति । तत्र तेषु रवेरासन्नो बुधः पञ्चविंशत्युत्तरत्रिशतयोजनव्यासः सूर्याच्चत्वारिंशल्लक्षयोजनान्तरे परिभ्रमति तत्परतः शुक्रः षष्ठ्युत्तराष्टशतयोजनव्यासः सूर्यात् पञ्चसप्ततिलक्षयोजनान्तरे परिभ्रमति तदुत्तरं पृथ्वी रवेः पञ्चल-

च्चोत्तरकोटियोजनान्तरे परिभ्रमति । तदुत्तरं मङ्गलः पञ्चा-शदधिकचतुःशतयोजनव्यासः सूर्यात् षष्टिलच्चोत्तरकोटियो-जनान्तरे परिभ्रमति तस्य गुरो श्च मध्ये परिभ्रमन्तो लघवो ग्रहा आधुनिकैर्ज्योतिर्विद्भिरेकविंशतिर्दृष्टाः । तत्परतो गुरुरयुत-योजनव्यासः पञ्चपञ्चाशत्प्रयुतयोजनान्तरे परिभ्रमति । तदुत्तरंशनिः सार्धद्विशतोत्तराष्टसहस्रयोजनव्यासः सूर्यात् दशकोटियोजनान्तरे परिभ्रमति। एवं परितो द्विधाभूतं म-हाचक्रं वर्तते तच्च दूरदर्शकयन्त्रमन्तरेण न लक्ष्यते। शन्युत्तरम-ष्टत्रिंशच्छतयोजनव्यास एको ग्रहो रवेर्विंशतिकोटियोजनान्तरे परिभ्रमन् प्रथमं हर्षलाख्यज्योतिर्विदा दृष्टोऽतः स द्रष्टृनाम्नैव प्रसिद्धः। हर्षलाख्यग्रहोत्तरं चतुःसहस्रयोजनव्यासो वरुणाख्यो ग्रहः सूर्यादेकत्रिंशत्कोटियोजनान्तरे परिभ्रमन्नधुना दृष्टः । एवमिदानीमेकोनत्रिंशत्सङ्ख्याकाः खस्थपिण्डा ग्रहत्वेन प्रसि-द्धाः । एवं केतवोऽपि बहवः सूर्यं परित एवात्यन्तदीर्घवृत्ता-कारमार्गेषु भ्रमन्ति ॥

। २ । ननु पूर्वं ग्रहत्वेन प्रसिद्धश्चन्द्रः कं परितो भ्रमति किमिति स प्रोक्तग्रहगणे नोक्त इत्याकाङ्क्षायामाह ॥

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चन्द्रस्तु भुवमभितो भ्रमति । अतः स साम्प्रत-
मुपग्रहः कथ्यते ॥ १९ ॥

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। १ । यथा बुधादयो ग्रहाः सूर्यमभितो भ्रमन्ति तथा चन्द्रः पृथिवीमभितो भ्रमति । अथ येषां कक्षाणां केन्द्रे रविर्वर्त्तते ते ग्रहाख्याः स्युर्येषां कक्षाकेन्द्रे ग्रहः स्यात् ते उपग्रहाख्याः स्युरित्याधुनिकैः परिभाषितम् ॥

। २ । ननु यथा भूमेरेक उपग्रहस्तथान्येषां ग्रहाणां कत्युपग्रहाः सन्तीत्याकाङ्क्षायामाह ॥

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एवं गुरोश्चत्वार उपग्रहाः सन्ति शनेरष्टौ हर्षलाख्यस्य षट् वरुणस्य चैकः ॥ २० ॥

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। १ । एवं भूम्यादयः खेटाः सर्वे स्वस्वोपग्रहैः साकं रविं परितो भ्रमन्तीति सिद्धान्तः ॥

। २ । एवं भूभ्रमे सिद्धे भूकक्षाव्यासतुल्येन द्रष्टुः स्थानभेदेनानुमितं नक्षत्रदूरत्वमाह ॥

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नक्षत्राणि भूमेः सूर्याच्च द्वाविंशतिनिखर्वयोजनेभ्योऽप्यधिकदूरेवर्त्तन्ते ॥ २१ ॥

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। १ । भूकक्षाव्यासतुल्येन द्रष्टुः स्थानभेदेन यदि कस्यचिन्नक्षत्रस्य लम्बनमेकविकलामितमप्युपलब्धं स्यात् तर्हि तस्य दूरत्वं द्वाविंशतिनिखर्वयोजनमितं सिद्ध्येत् परं न कस्याऽपि नक्षत्रस्यैका विकलापि लम्बनं लभ्यत इति नक्षत्राणां दूरत्वं

भूमेः सूर्याच्च द्वाविंशतिनिखर्वयोजनेभ्योऽप्यधिकं सिद्ध्याति तथा च एकेन पलेन पञ्चलक्षयोजनान्यतिक्रामन् प्रकाशः नक्षत्रान्निर्गत्य सपादेभ्यस्त्रिभ्यो वर्षेभ्योऽप्यधिके न कालेन भुवमायाति । अत एव नक्षत्राणि यत्रास्माभिर्लोक्यन्ते तत्र तानि त्र्याद्यैर्वर्षैः पूर्वमेवायातानीत्यनुमीयते । एवमन्याननुमितानर्थानाह ॥

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तानि च सूर्यवत्स्वप्रकाशानि कतिचित् सूर्यसमानि कतिचन ततोऽपि महान्ति कतिचित् ततोऽल्पानि सन्ति । यथास्माभिस्तानि बिन्दुवल्लोक्यन्ते तद्वदयं सूर्योऽपि तत्र बिन्दुवद्दृश्यः स्यात् । यथा सूर्यात् सन्निहितमपि नक्षत्रं द्वाविंशतिनिखर्वयोजनेभ्योऽधिके दूरे वर्तते तद्वत् सर्वाणि नक्षत्राणि मिथो विप्रकृष्टानि स्युः । तानि चानन्तानि । योऽयमाकाशे छायापथो दृश्यते स केवलं नक्षत्रपुञ्जप्रकाश एव ॥ १४ ॥

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। १ । तानि चानन्तानीति । केवलेनाक्ष्णा यावन्ति दृश्यन्ते तावन्ति तु गणनीयानि किन्तु दूरदर्शकयन्त्रद्वारासङ्ख्यान्यन्यानि दृश्यन्ते । छायापथस्यैकस्मिन् वर्गांशे पञ्चसहस्राधिकानि नक्षत्राणि हर्षलाख्यज्योतिर्विदा दूरदर्शकयन्त्रद्वारा दृष्टानि ॥

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। २ । इति श्रीमज्जेम्सबालण्टैनविरचितायां न्यायकौमुद्यां सङ्ख्यापरिमाणतत्प्रमितज्योतिर्गतिविचारो नाम तृतीयो ऽध्यायः ॥

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। ३ । एवं तृतीये ऽध्याये सिद्धा गतीर्निरूप्येदानीं गतिस्थितिकारणानि निरूरूपयिषुर्गतिकारणस्य नाम निर्दिशति ॥

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गतिकारणं बलम् ॥ १ ॥

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। १ । अथ बलस्याश्रयमाह ॥

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परमाणुस्तत्समुदायश्च बलाश्रयः ॥ २ ॥

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। १ । परमाणुरिति । तत्र जगति सर्वे द्रव्यपदार्थाः सावयवाः । अवयवेषु च कचनातिसूक्ष्मा मनुष्यशक्त्यनाश्याः सन्ति यतो लोहादिधातुखण्डः सहस्रवारं चुर्णो भग्नोऽग्निसंयोगेन विलापितो विकृतोऽपि व्यस्तावयवसङ्ग्रहमात्रेण पुनर्यथावत् प्रदर्शयितुं शक्यते तेचैवंविधाः सूक्ष्मतमा अवयवाः परमाणव इत्युच्यन्ते ॥

। २ । अथ परमाणुतत्समुदायोभयधर्मभूतान् बलविशेषानद्दिशति ॥

तदाकर्षणोत्सारणजडत्वाख्यास्त्रयो बलविशेषाः ॥ ३ ॥

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। १ । तदिति तयोः परमाणुतत्समुदाययोः ॥

। २ । आकर्षणेति । परमाणवः पृथग्भूत्वा कार्य्यीभूय वा अन्यपरमाणून् प्रति जिगमिषवो भवन्तीति दृश्यते । यथा पाषाणादिकार्य्यस्यांशाः केनचिद्बलेन संयुक्तास्तिष्ठन्तीति दृश्यते । यथा वा पतितः पाषाणः केनचिद्बलेन भूम्या सह संयुक्तस्तिष्ठतीति दृश्यते । यथा वा समुद्रश्चन्द्रम्प्रति जिगमिषुर्दृश्यते । अत्र कारणं तत् आकर्षणाख्यं स्यात् ॥

। ३ । उत्सारणेति । परमाणूनां परस्पराकर्षणे कश्चित्प्रतिबन्धो दृश्यते । यथा यत्रोष्णतायाः प्रवेशस्तत्र । तदा परमाणूनां मिथो विश्लेषो लक्ष्यते । तथाहि । हिममुष्णता प्रविशेत्तर्हि जलमुत्पद्यते । अपिच जलमुष्णता प्रविशेत्तर्हि वाष्प उत्पद्यते । अत्र कारणमुत्सारणाख्यं स्यात् ॥

। ४ । जडत्वमिति । यथा कुम्भकारस्य चक्रं भ्रमणकाले प्रथमं स्वामकयत्नं रुणद्धि किन्त्वनन्तरं क्रमशः तद्बलशक्त्यनुसारेण शीघ्रगतिं लभते तथाच स्वशैघ्र्यानुसारेण स्वगमनप्रतिरोधयत्नं प्रतिकरोति तथैव सर्वाणि कार्य्याणि परमाणवश्च स्थैर्यगमनयोरपेक्षायां केनचिदविकारित्वेन विशिष्टा इति दृश्यते । तत्र कारणं जडत्वसंज्ञं स्यात् ॥

।५। अथ परमाणूनामाकर्षणादिधर्मविचारात् इन्द्रियग्राह्य-गुणवत्संसारधर्मज्ञानसम्भवः प्रदर्श्यते ॥

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इन्द्रियग्राह्यगुणवत्संसारोऽयं परमाणुनिर्मितः ॥ ४ ॥

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।१। लोहादिधात्वंशः सहस्रवारं क्षुण्णो भग्नो गलितो विकृतोऽपि सदा यथावत् दर्शयितुं शक्य इति पूर्वं कथितम् । यद्यपि वृक्षपत्रादीनां पक्षिपक्षादीनां वा तादृशो धर्मो नास्ति यतो जीवित्वसाधनविशिष्टपदार्थकर्तृत्वमस्मदादीनामसम्भावि तथापि वृक्षादीनां ज्वलनादिकाले ऽप्येको ऽपि परमाणुर्न नश्यतीति रसायनप्रकरणे प्रदर्श्यते ॥

।२। अथ परमाणूनामतिसूक्ष्मतामुपपादयति ॥

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परमाणुसौक्ष्म्यं दुर्निश्चेयम् ॥ ५ ॥

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।१। दुर्निश्चेयमिति । तथाहि । स्वर्णयानि हि पत्राणि लोहाभिघातेन तादृशीं सूक्ष्मतामापादयितुं शक्यन्ते यथैषां षष्टिसहस्रोत्तरलक्षत्रयसङ्ख्याकानामधरोत्तरभावापन्नानां समुच्चय एकाङ्गुलोच्चो भवति । नचैतान्येतस्यामप्यवस्थायां सच्छिद्राणि । स्वावृतपदार्थान्तरे प्रत्येकं सुवर्णमयत्वप्रत्ययजनकत्वात् । रजतादिसूत्रखचितस्य स्वर्णस्य त्वितोऽप्यधिकासूक्ष्मतास्ति । नच तस्या अपि परमाणवीयसूक्ष्मतासमत्वं निश्चीयते ।

स्वर्णलिप्तस्य रजतादिसूत्रस्याम्लरसविशेषप्रक्षेपे कृते तदम्लमाहात्म्येन रजतविलयोत्तरमुपरितनलेपभूतस्वर्णस्य सूक्ष्मनलिकारूपेणावशेषदर्शनात् ॥

। २ । परमाणूनां परिमाणं सर्वपरिमाणेभ्यः सूक्ष्मं भवति तच्च न द्व्यणुकपरिमाणोत्पत्तौ कारणम् । अणुजन्यस्याणुतरत्वप्रसङ्गात् । किन्तु तत्रान्यदेवेश्वरेच्छादिकमगत्या कारणं वक्तव्यमिति न्यायसिद्धान्तः । अस्मिन्सिद्धान्तस्तु तत्तज्जातीयपरमाणूनां तत्तज्जातीयसर्वद्रव्येभ्यः सूक्ष्मतरत्वेऽपि तत्तज्जातिनियतमहत्त्वस्वीकारे न किंचिदपि बाधकम् । एवं च परमाणुपरिमाणं द्व्यणुकपरिमाण एकं कारणमित्यस्योपपत्तिरग्रे वक्ष्यते ॥

। ३ । यत्तु निष्परिमाणा एव परमाणवो विरोधनामको वक्ष्यमाणधर्मश्च तेषां स्वाभविक एवेति युरोपदेशीयस्य बास्कविकाख्यस्य मतं साक्षाद्बाधविरहेऽपि भौतिकवस्तुतत्त्वनिर्णये ऽल्पतरोपकारकत्वादस्मन्मतापेक्षया न वरम् ॥

। ४ । ननु परमाणूनां सौक्ष्म्यस्य दुर्निश्चेयत्वे तेषां किंचित् परिमाणमस्तीत्यत्र किं मानमित्याकाङ्क्षायामाह ॥

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भौतिकपदार्थाः कदापि परिमाणरहिता न भवन्ति ॥ ६ ॥

। १ । कदापीत्यादि । तूलराश्यादीनां हि महत्प्रदेशव्यापिनां द्रव्याणामल्पतमप्रदेशस्थायिता शक्यते कर्तुं न पुनः कथमपि देशसम्बन्धसामान्याभावः । सोऽयं द्रव्याणां देशसम्बन्धनियमो द्रव्ययोर्विरोधे पर्यवस्यति । तथाहि । विरोधो नाम द्रव्यद्वयस्यैककालावच्छेदेनैकत्र स्थित्यभावः । उभयतोमुख्यां हि काचनलिकायामेकं मुखमङ्गुल्या पिधायापरमुखेन जले सरलं निमज्जितायां जलं नान्तर्विशति । तत्र वायोःसत्वात् । यदा तु मुखपिधानभूताङ्गुल्यपसारणेन वायोर्निर्गमनावाकाशो दीयते तदा सा नलिका बाह्यजलपृष्ठपर्यन्तं जलेनान्तः पूर्यते तत्र वायोरभावात् । एतेनाधोमुखपात्रस्य जलनिमग्नतादशायां तत्र जलप्रवेशाभावो व्याख्यातः । अधो मुखनिमज्जितस्य सुदूरगभीरेऽपि जलप्रदेशे नीतस्य पात्रस्यान्तर्वर्तिका तरति ज्वलति च तत्र वायोः सत्त्वात् । एवं मज्जनघण्टायां मनुष्य जीवनादिकमप्येतद्विषयोदाहरणं द्रष्टव्यम् ॥

। २ । अथ क्रमप्राप्तमाकर्षणाख्यं बलविशेषं निरूपयति ॥

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संयोगानुकूलं बलमाकर्षणम् ॥ ७ ॥

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। १ । संयोगानुकूलमिति । तथाहि । एकः परमाणुस्तत्समुदायो वापरं परमाणुं तत्समुदायं वा जिगमिषुर्भवति । यथा ॥

। २ । पाषाणादेरवयवाः परस्परं संयुक्तास्तिष्ठन्ति ।

। ३ । निराधारः पाषाणो भूमिं प्राप्यैव विरमति ॥

। ४ । स्थिरजले तडागादौ प्लवमाना नौकाष्ठखण्डादयः क्रमेण परस्परं संयोगं प्राप्य तथैवावतिष्ठन्ते ॥

। ५ । भारतवर्ष इव ततः कुदलान्तरेऽपि जना ग्रामनगरादयश्च वर्तन्ते । आन्दोलकाश्च भूकेन्द्राभिमुखमेवावलम्बन्ते । केवलं तु तत्रत्या सर्वा स्थितिर्नीरतीरस्थपुरुषाणां छायापुरुषस्थितिवत् भारतवर्षीयजनानां विपरीता भासते । अयमेवाऽर्थो भास्कराचार्यैर्गोले वर्णितः । तथाहि भूमेः पिण्ड इत्युपक्रम्य

सर्वतः पर्वतारामग्रामचैत्यचयैश्चितः ।
कदम्बकुसुमग्रन्थिः केसरप्रसरैरिव ॥
यो यत्र तिष्ठत्यवनीं तलस्थां ।
मात्मानमस्या उपरिस्थितं च ॥
समन्यतेऽतः कुचतुर्थसंस्था ।
मिथश्च ते तिर्यगिवामनन्ति ॥
अधःशिरस्काः कुदलान्तरस्था ।
श्छायामनुष्या इव नीरतीरे ॥
अनाकुलास्तिर्यगधःस्थिताश्च ।
तिष्ठन्ति ते तत्र वयं यथात्र ॥

। ६ । परमाणूनामेककेन्द्रगामित्वादियं पृथ्वीगोलरूपा जाता ॥

। ७ । कुज्झटिकाशीकरा अपि संयुक्ताः सन्तो गोलाकार-

जलबिन्दुरूपा भवन्ति । तेषां तु गोलत्वं भूमिप्राप्तेः पूर्वं दृश्यते ॥

। ८ । उच्चस्थानस्थचालनीतः पातितस्य द्रुतसीसकस्य बिन्दवस्तु भूमिं प्राप्ता अपि गोलाकारत्वं न त्यजन्ति । अनयैव युक्त्या पक्षिहननार्थं सूक्ष्मान् सीसककणान् निर्मान्ति ॥

। ९ । एवमद्रवाणां पदार्थानामुच्चस्थानात् पातितानामपि गोलरूपत्वादर्शनाद्द्रवाणां च नियमतस्तथात्वदर्शनात् पृथ्वी चन्द्रः सूर्यो ग्रहाश्च सर्वे कदाचिद्द्रुतपिण्डरूपा आसन्नित्य-नुमीयते ॥

। १० । ननु सर्वेषां वस्तूनां भूकेन्द्राकृष्टिवशाद्भूकेन्द्राभिमुख-गामित्वे धूमः कुतो भूकेन्द्रं प्रति न गच्छतीति चेत् प्रतिबन्धक-सद्भावात् । तथाहि नैष धूमस्य स्वभावो यदयमूर्ध्वं गच्छति कि-न्तु भूसमीपस्थवायुः स्वस्माल्लघुं धूममूर्ध्वं गमयति गुरोर्लघुपदा-र्थोत्थापकत्वं च निमज्जिततृणाद्युत्थापके जलादौ दृष्टमिति ॥

। ११ । भूगोलात् षट्शतोत्तरपञ्चसहस्राधिकलक्षक्रोशा-न्तरेऽपि वर्तमानश्चन्द्रः स्वाभिमुखं समुद्रजलमाकर्षति । सैव च समुद्रस्य वृद्धिरित्युच्यते । एवमत्यन्तदूरवर्ती सूर्योऽपि समुद्रज-लमाकर्षति । अत एव यदा सूर्याचन्द्रमसौ युगपत् समुद्राभि-मुखौ भवतस्तदा समुद्रवृद्धिरधिका भवति ॥

। १२ । अथ यद्यप्यतिदूरप्रदेशेऽप्याकर्षणरूपो धर्मो न नश्यति तथापि दूरत्वेनाल्पीक्रियतइत्याह ॥

भौतिकपदार्थानां परस्परसन्निधानतारतम्यात् परस्पराकर्षणतारतम्यं भवति । दीपसामीप्यदूरत्वविशेषात् तत्तेजस आधिक्यन्यूनत्ववत् ॥ ८ ॥

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। १ । दीपसामीप्येत्यादि । हस्तपरिमितभुजैर्वर्गाकारकाष्ठखण्डैर्घटिताया घनाकारमञ्जूषाया मध्यभागे स्थितो दीपो यथा तां प्रकाशयत्येवं द्विहस्तपरिमितभुजवर्गाकारकाष्ठखण्डघटितघनाकारपेटिकामध्यनिहितस्तामपि प्रकाशयति परन्तु पूर्वामपेक्ष्योत्तरस्याश्चतुर्गुणविस्तृततया पूर्वातुल्य उत्तरस्याश्चतुर्थेऽंशे तेजसोऽपि चतुर्थ एवांशो वर्तते । अतश्च द्रव्यप्रकाशनं तत्र न्यूनम् । तथाच दीपस्य द्रव्यप्रकाशने यो नियमो वर्तते तेनैव नियमेन यथा द्रव्याणि दूरे दूरे स्युस्तथा तथा तदाकर्षणमपि न्यूनं न्यूनं भवति । एवं च यस्मादाकर्षकादेकसङ्ख्याकामुकदूरत्वविशिष्टे यद्द्रव्ये यावदाकर्षणं जायते तस्मादाकर्षकादनेकसङ्ख्याकतद्दूरत्वविशिष्टे तद्द्रव्ये तदीयदूरत्वसङ्ख्यावर्गविभक्तेन तावदाकर्षणेन तुल्यमाकर्षणं भवति । तथाहि यत्र हस्तद्वयमितमन्तरं तत्र चतुर्थांशतुल्यमाकर्षणम् । यत्र हस्तत्रयमितं तत्र नवमांशतुल्यं यत्र हस्तचतुष्टयमितं तत्र षोडशांशतुल्यमित्यादि गणितज्ञैर्विभावनीयम् । तुलामानपरीक्षया चेदं सिद्धम् । यद्धि द्रव्यं समुद्रतीरे सहस्रपलमितं भवति तस्य पर्वतशिखरे नीतस्य मानं कैश्चित् पलैर्न्यूनं भवतीति । ननु कथमेतत् संभवति

मानं हि तुलयैकस्मिन् घटे मापकमपरस्मिंश्च मेयं विन्यस्य क्रियते तत्र पर्वताग्रे यदि मेयस्य मानं न्यूनं स्यात् तर्हि मापकस्यापि स्यादेव हेतुसाम्यादिति चेन्न । तदाहीदं दूषणं यदि व्यवहारप्रसिद्धया तुलयोक्तविषयसाधनं प्रतिज्ञातं भवेत् । अस्माभिस्तु प्रकृतकार्यसाधनाय सज्यं धनुरुपादीयते । अथाधः कृतकोटिद्वयकस्य तस्य दण्डं हस्तेन मध्येऽवलम्ब्य ज्यामध्ये सहस्रपलमितं द्रव्यं सूत्रेणावलम्ब्यते तेन च यावती ज्यानतिः समुद्रतीरे भवति न तावत्येव पर्वताग्रे किन्तु ततो न्यूनैव । यथा च पर्वत उच्चः स्यात् तथा तथा ज्यानतिर्न्यूना भवति तेन चोत्तरोत्तरं गुरुत्वस्य न्यूनतानुमीयते । समुद्रतीरस्य ज्यानतिसंपादनायाधिकद्रव्ययोजनस्यापेक्षितत्वाच्च । एवं च यः पदार्थो भूमौ सहस्रपलोऽस्ति स एव चन्द्रो यावद्दूरे वर्तते तावत्यन्तरे नीतः सन् पञ्चपलमात्रो भविष्यतीति गणितेन निश्चीयते ॥

। २ । एवं पात्रविशेषात् पात्यमानं जलं समनन्तरमेव न सरलधारया पतति । अपि तु परस्पराकर्षणमाहात्म्यात् तत्पात्रस्य ग्रीवाप्रदेशं प्रति याति । अत एव निस्तोटिकात् पात्राज्जलपातनं दुष्करम् । अतो जले यद्भाण्डकृताकर्षणं तन्निरसनाय नलीविशिष्टानि पात्रविशेषाणि निर्मीयन्ते । तादृशानि पात्राणि कमण्डल्वाख्यानि प्रायो भारतवर्षीयतपस्विनां निकटे दृश्यन्ते । अथ यदि नलीरहितपात्रात् तथा जलं पातयितुमिष्यते यथा तत्पात्रबहिर्देशेऽलग्नं सत् पतेत् तदा पात्रमुखे जल-

पतनस्थले काचादिदण्डं संस्थाप्य पातयेत् । तथाच तत्पातक्र-ताकृष्टिविरुद्धं दण्डकृताकर्षणं भवति तेन दण्डद्वारा सर्वं जलं पात्रालग्नं सत् बहिः पतति ॥

। ३ । एवं जलकणा मिथः संलग्ना भवन्ति येन सूक्ष्मा सू-च्यपि जलपृष्ठे मन्दं मोचिता सती तत्र प्लवते । तत्सूचीभारो जलपृष्ठं भेत्तुं न शक्नोति । एवमेवान्याः कीटमक्षिकादयः पानीयपृष्ठोपरि वार्यलिप्ता गन्तुं शक्नुवन्ति ॥

। ४ । अन्योन्यलग्ने जलमग्नाधरभागे द्वे काचादिपत्रे स्वम-ध्यदेशेऽन्योन्यसान्निध्यानुसारतो जलमाकर्षतः । तेन जलं स्व-पृष्ठादूर्ध्वं गच्छति । एवं पानीयस्य मस्यास्तैलस्य वा विन्दुः पुस्तकपार्श्वभागे पतितः सन् शीघ्रं पत्रान्तः प्रविश्य दूरं प्रस-रति । एवं दीपवर्तिर्द्विवाङ्गुलप्रमाणदूरदेशादपि तैलमाक-र्षति ॥

। ५ । अथ क्रमप्राप्तमुत्सारणाख्यं बलविशेषं निरूपयति ॥

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## विश्लेषानुकूलं बलमुत्सारणम् ॥ ८ ॥

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। १ । विश्लेषेति । उत्सारणाख्यं बलमौष्ण्याद्धि समावेशा-वस्थायां कार्यक्षमं भवति । तथाहि । उष्णीकृतहिमस्य स्वा-वयवविश्लेषाज्जलरूपता । उष्णीकृतजलस्य च तत्र वाष्परूप-ता । एतदेवप्रपञ्चयति ॥

उष्णतायास्तारतम्यात् परमाणुषु घनत्वविरल-
त्वतारतम्यम् । तत्कृतमेव बहिर्द्रव्याणामाकारत्रै-
विध्यम् । घनत्वद्रववायुभेदात् ॥ १० ॥

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। १ । उष्णताया इति । उष्णतायाः स्वरूपमग्रे विचार-यिष्यते ॥

। २ । घनत्वविरलत्वतारतम्यमिति । तथाहि सततं सन्ताप्यमानस्य कस्यापि द्रव्यस्यावयवानां परस्परान्तरं क्रमेण वर्धते तेन तद्द्रव्यं विस्तृतं भवति । तत्र घनं प्रथमतो विस्तृतं मृदु च भवति । ततः पिण्डीभवनानुकूलाकर्षणशक्तेर्मन्दीकृतत्वाद् द्रव-रूपतां याति । अन्ते च परमाणुष्वधिकमन्तरं सम्पद्यते येन तद्द्रव्यं वायुरूपं भवति । एतादृशवायोः सकाशादुष्णतानि-ष्काशनं विलोमक्रमेण तद्द्रव्यस्य पुनः पूर्वावस्थाप्राप्तौ हेतुः । य-था हिमं सन्ताप्यमानं जलं भवति । जलं चात्यन्तानलसंयोगेन बाष्परूपं भवति तच्च बाष्पं शीतीक्रियमाणं पुनः पूर्ववज्जलं भवति । जलं शीतीक्रियमाणं हिमं भवति । अतो हिमजल-बाष्परूपास्त्रयोऽप्याकारा एकस्यैव वस्तुन इति निश्चीयते । एव मेवान्यान्यपि द्रव्याण्युष्णतया विक्रियन्ते । तत्र कानिचिद-त्यन्तोष्णतासंयोगेन लीयन्ते कानिचिच्चात्यल्पोष्णतायोगेनेत्य-तोऽस्मिन् संसारे बहिर्द्रव्याणां समकालमेवोपलभ्यमानं घनद्र-ववायुभेदादाकारत्रैविध्यमुपपद्यते ॥

। ३ । उष्णताया आत्यन्तिकात्यल्पत्वयोः परिच्छेदकानि यन्त्राण्युष्णताप्रकरणे वक्ष्यन्ते ॥

। ४ । अथाकर्षणोत्सारणयोर्विशेषाद्द्रव्येषु जायमानान् धर्मविशेषानाह ॥

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नियताकारत्वं सान्तरत्वं घनत्वं कठिनत्वं स्थिति-
स्थापको भङ्गुरत्वं पत्रीकरणीयता सूत्रीकरणीयता
भारालम्बनशक्तिरिति नव परमाणूनां संस्थानवि-
शेषा आकर्षणोत्सारणशक्तिवैचित्र्यप्रभवाः ॥ ११ ॥

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। १ । नियताकारत्वमिति । यदा यदा लवणजातिर्जल संयोगाद्विलीयते तदा तदौष्णतया तत्रत्यजले शोषिते सा स्वस्वजाति नियतमेकविधमेवाकारं गृह्णातीति केषांचित् पदार्थानां स्वीयाकारनियमविशिष्टोत्पत्तिदर्शनादिदमनुमीयते यत् तत्पदार्थपरमाणुषु काचिच्छक्तिर्विद्यते यया कार्यारम्भकाले ते प्रतिपरमाणून् न सर्वैः पार्श्वैराकर्षन्ति किन्तु केनचिदेकेनैवेति । साच शक्तिर्नियताकारत्वमित्युच्यते ॥

। २ । सान्तरत्वमिति । कठिनपाषाणस्याप्यवयवाः सान्तरा भवन्ति । अत एव सैकतपाषाणविशेषस्य पानीयशोधन उपकर्तृत्वम् । तत्र कारणं सान्तरत्वसंज्ञं स्यात् ॥

। ३ । घनत्वमिति । घनहस्तपरिमितपारदस्तन्मितादेव

पानीयात् स्वल्पान्तरचतुर्दशगुणो गुरुर्भवति। अस्मादिदमनु-मीयते। यथा यथा पदार्थानां गुरुत्वाधिक्यं तथा तथा निर्दिष्टा-वकाशे तत्परमाणुसमुदायाधिक्यम्। कश्चन पदार्थः कस्माच्चि-द्घन इत्यस्याप्ययमेवार्थः। यदा कश्चित् पदार्थ उष्णतासमावेशेन विस्तृत उष्णतानिर्गमेण संकुचितो वा भवति तदा तदीयपर-माणुसमूहस्य यथापूर्वत्वात् न तद्गुरुत्वं विक्रियते। परन्तु नि-र्दिष्टावकाशावच्छिन्नस्य तदवयवस्य परमाणुसङ्ख्याभेदाद्गुरुत्वं भिद्यत एव। एष एव धर्मो घनत्वमित्युच्यते॥

। ४। कठिनत्वमिति। एकस्य द्रव्यस्य द्रव्यान्तरविलेखन-शक्तिमत्त्वमित्यर्थः। यथा ज्ञातद्रव्याणां मध्येऽतिकठिनो हीरकः सर्वानन्यान् पदार्थान् विलिखति स्वयन्तु हीरकान्तरशकलैरेव साधनभूतैः सुघटिताकारो भवति॥

। ५। स्थितिस्थापकइति। अन्यथाकृतस्य पुनस्तादव-स्थ्यापादकः स्थितिस्थापकः॥

। ६। भङ्गुरतेति। येन धर्मेण कठिनमपि द्रव्यं स्वल्पेना-प्याघातेन भग्नं भवति स भङ्गुरत्वसंज्ञः स्यात्। यथा काचो लोहपृष्ठं छिनत्त्यतः स लोहमपेक्ष्य कठिनतरस्तथापि काचः स्वल्पाघातेन भग्नो भवति॥

। ७। पत्नीकरणीयतेति। सुवर्णादिकं घनादिना ताडितं सद्यद्धर्मवशात् पत्ररूपं गृह्णाति स पत्नीकरणीयतेत्युच्यते॥

। ८ । सूत्रीकरणीयतेति । यद्धर्मवशात् सुवर्णादिकं सूत्र-रूपं भवितुमर्हति स सूत्रीकरणीयतेत्युच्यते ॥

। ९ । भारालम्बनशक्तिरिति । यद्धर्माधिक्याल्लोहसूत्रं स्वप्रान्तलग्नं महान्तमपि भारं सहते यद्धर्मापकर्षात् सीसकसूत्रं न तावन्तं किन्त्वत्यन्ताल्पमेव भारं सहते स द्रव्यजातिभेदाद्भि-न्नो धर्मो भारालम्बनशक्तिरित्युच्यते । सर्वद्रव्यसाधारणस्या-प्यस्य लोहे परमोत्कर्षः ॥

। १० । अथ क्रमप्राप्तं जडत्वाख्यं बलविशेषं निरूपयति ॥

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गतिस्थित्यन्यतरापरित्यागानुकूलं बलं
जडत्वम् ॥ १२ ॥

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। १ । जडत्वमिति । यथा कुम्भकारस्य चक्रं प्रथमतो भ्रा-मक बलं विरुणद्धि । तदेव भ्रामकबलतारतम्याज्जनिततारतम्य-मासाद्य ततः प्रवृत्तं स्थिरीकारकबलं विरुणद्धि । एवमकस्मा-द्रथस्य गमनमनु तत्रस्थो मनुष्यः पश्चात् पतति । एवं शीघ्रं गच्छतो रथस्य स्थैर्यमनु तत्रस्थो मनुष्यो ऽग्रे पतति । एवं नद्यां गच्छन्ती नौर्यदाकस्मात् तीरे लगति तदा ततः शीघ्रमवरो-ढुमुत्तिष्ठन्तोऽज्ञानिनस्तीरे पतन्तीति प्रसिद्धम् । एवं सर्वेषु कार्यद्रव्येषु परमाणुषु च गतिस्थित्यन्यतरापरित्यागानुकूलं बलं दृश्यते तदेव जडत्वमित्युच्यते ॥

। २ । अथ प्रकृत विचारस्य मुख्यविषयभूते गतिस्थिती निरूपयिष्यन् प्रथमोपस्थिताया गतेर्लक्षणमाह ॥

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द्रव्याणां देशान्तरसंयोगानुकूलव्यापारो
गतिः ॥ १३ ॥

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। १ । गतिसामान्याभावो हि स्थितिरितिस्पष्टम् ॥

। २ । अथ स्थितिः स्वाभाविकी गतिस्त्वौपाधिकीति लौकिकं मतं निरसितुं स्थितेरिव गतेरपि स्वाभाविकत्वमित्याह ॥

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द्रव्यस्य स्थितिः समानसरलगतिश्चेति द्वे अपि
स्वाभाविक्यौ ॥ १४ ॥

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। १ । स्वाभाविक्याविति । असति बाधके चिरस्थायिन्यावित्यर्थः ॥

। २ । तत्र यथा स्थितिरुपाधिमन्तरेण न निवर्तते तथा गतिरपि कंचनोपाधिं विना न क्षीयते न वर्धते नच भिन्नदिक्का भवति ॥

। ३ । अयोगोले भूमौ प्रक्षिप्ते यदि भूः समा न स्यात् तर्हि तद्गमनमत्यल्पकालं तिष्ठति । यदि च समा स्यात् तर्हि किंचिदधिककालं तिष्ठति गमनप्रतिरोधस्याल्पत्वात् । परन्तु भूगोलस्थानां सर्वेषामपि पदार्थानां गतिः कदाचिन्नश्यत्येव

प्रतिरोधावश्यंभावात् । प्रतिरोधसामान्याभावस्तु खगोल एव सम्भवत्यत एव तत्र ग्रहाणां गतिः कदापि न विरमति ॥

। ४ । सम्मुखदिशि वर्तमानं किंचिल्लक्ष्यमुद्दिश्य मुक्तः शरो भूम्याकृष्टिहेतोरुत्तरोत्तरमधो याति परन्तु वायोः स्थिरत्वेन वामतो दक्षिणतो वा वलति । यदि गतेरयं धर्मो न स्यात् तर्हि शरेण लक्ष्यवेधो दुष्करः स्यात् ॥

। ५ । सपाषाणे भिन्दिपाले भ्रामिते यदा पाषाणस्ततो निर्गच्छति तदा चापमौर्विकातो मुक्तः शर इव स सरलमेव व्रजति परन्तु पाषाणभ्रममण्डलस्य यस्मात् स्थानान्निर्गतः स लक्ष्ये लगेत् तत्स्थाननिर्णयोऽभ्यासेनापि दुःशकोऽतोऽनेन लक्ष्यहननमपि दुःशकम् ॥

। ६ । अस्मादिदमवगम्यते यत् कस्मिंश्चिन्मण्डले भ्रमद्द्रव्यं स्वगत्यनुकूलजडत्वविरुद्धबलाधीनं भवति । यथा भिन्दिपालस्थपाषाणो भ्रमणकाले सरलगमनानुकूलजडत्वविरुद्धस्य हस्तबलस्याधीनो भवति ॥

। ७ । अथ गतेर्दिङ्नियममाह ॥

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बलप्रवृत्तिरेव गतेर्दिक् ॥ १५ ॥

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। १ । यथा पूर्वगामिना गङ्गाप्रवाहेण पूर्वदिश्येव नौर्नीयते । यदा तु पूर्वप्रवृत्तबलदिश्येवापरं बलं प्रवर्तते तदा

न

समानदिश्येव शीघ्रतरं गमनमुत्पद्यते । यथा गङ्गाप्रवाहे वह-न्तीं नावं प्रवाहानुलोमगतिर्वायुः पूर्वामेव दिशं प्रति शीघ्रतरं नयति । यदा तु पूर्वप्रवृत्तबलविरुद्धदिशि समानमन्यद्बलं प्रव-र्तते तदा गमनं नश्यति । यथा यदा समबलावृषभौ मिथः शिरःसंयोगं कृत्वा समेन बलेन यत्नं कुरुतस्तदोभावपि न परावर्तेते । एवं यदा पूर्वप्रवृत्तबलविरुद्धदिशि न्यूनमधिकं वा-न्यद्बलं प्रवर्तते तदा तद्बलद्वयान्तरजातशैघ्र्येणाधिकबलप्रवृत्ति-दिशि गमनमुत्पद्यते । यथा यदा नौरनुकूलवायुबलेन गङ्गा-प्रवाहविलोमदिशि गच्छति तदा प्रवाहवायुबलान्तरजातशैघ्र्ये-णाधिकबलप्रवृत्तिदिशि तस्या गमनं भवति ॥

। २ । अथाविरुद्धासमानगमनदिक्प्रवृत्तिकबलद्वयस्थलीयं विशेषमाह ॥

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गमनकारणयोर्दिशौ यदि न समाने नच विरुद्धे
तदा गमनं तद्दिशोर्मध्ये भवेत् ॥ १६ ॥

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। १ । यथा नदीप्रवाहक्षेपणिभ्यां प्रवर्तिता नौस्तदुभयबल-प्रवृत्तिदिशोर्मध्ये गच्छति । अत एव पार इष्टघट्टे नौप्रापणार्थं नाविकः स्वस्य नदीप्रवाहस्य च बले विचिन्त्यार्वाक्तीरस्य तस्मात् स्थानान् नावं मुञ्चति यत्सम्मुखदिशः प्रवाहदिशश्च मध्यदिशीष्टघट्टो वर्तते ॥

। २ । अथ सरलगमनानुकूलस्य निर्दिष्टकेन्द्रसन्निकर्षानुकूलस्य चेति द्वयोः सततं प्रवृत्तयोर्बलयोः कार्यं विशेषमाह ॥

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यत्र गतेर्द्वौ हेतू भवतो ययोरेकेन सरलरेखायां गमनं भवेदपरेण च सदा कंचन निर्दिष्टबिन्दुं प्रति तत्र चक्राकारभ्रमणमुत्पद्यते ॥ १७ ॥

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। १ । यथा भिन्दिपाले हस्तेन भ्रामिते तत्रस्थः पाषाणो दूरमपसर्तुमिच्छुरपि हस्ताकृष्ट्या चक्राकारमार्गं गच्छति । तत्र यदि भिन्दिपालः शीघ्रभ्रमणकाले भग्नो हस्ताच्च्युतो वा स्यात् तदा तत्रत्यः पाषाण एकेनैव बलेन प्रचोदितो हस्तेन प्रक्षिप्त इव सरलं गच्छेत् ॥

। २ । एवं तैलिकयन्त्रेऽपि वृषभः प्रचोदितः स्वयं सरलमार्गं जिगमिषन्नपि कण्ठबद्धतिर्यक्काष्ठावरोधेन चक्राकारमार्गं मध्यकाष्ठं परितो भ्रमति । यदा स कण्ठबद्धकाष्ठाद्विमुक्तो भवेत् तदा सरलं गच्छेदिति सम्भाव्यते यतस्तस्य सरल गमनाकूनुलः प्रयत्नः पूर्वं चक्राकारभ्रमणकारणे न प्रतिबद्धोऽभूत् ॥

। ३ । अथोक्तयोर्बलयोः सामान्यविशेषसंज्ञा आह ॥

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तत्र निर्दिष्टकेन्द्रसन्निकर्षानुकूलं बलं केन्द्राकृष्टिबलं निर्दिष्टकेन्द्रविप्रकर्षानुकूलं जडत्वात्मकं बलं

केन्द्रोत्सृतबलं तदुभयं च केन्द्रबलं स्यात् ॥ १८ ॥

। १ । तत्र केन्द्रोत्सृतिबलकार्याण्युच्यन्ते ॥

। २ । तिर्यग्भ्राम्यमाणेषु कुलालचक्रादिषु स्थिताः पदार्था दूरमपसरन्ति ॥

। ३ । पेषणयन्त्रे क्षिप्तं धान्यं तदुपरितनशिलया भ्राम्यमाणं सत् तन्मध्याद्बहिःपातं यावद्दूरतोऽपसरति ॥

। ४ । जलपूर्णे घटे ग्रीवायां रज्ज्वा बद्ध्वोर्ध्वाधरं घूर्णिते तत्स्थं जलं केन्द्रोत्सृतिबलवशान्न पतति ॥

। ५ । कस्यचिन्मनुजस्याश्वस्य वा धावतो यदा मार्गकोणपरिक्रमणादावकस्माद्गमनदिग्भेदश्चिकीर्षितो भवति तदा स स्वपतनहेतोः केन्द्रोत्सृतिबलस्य प्रतीकाराय स्वबुध्यैव तस्यां दिशि नम्रो भवति । अचेतनस्य तु शकटादेस्तादृशस्थले बहुधा पतनं भवति ॥

। ६ । एवमतिकोमलपङ्कपिण्डः कुलालचक्रमध्ये स्थापयित्वा शीघ्रं घूर्णितः केन्द्रोत्सृतिबलेन प्रसरति ॥

। ७ । अथैवं निरूपितां गतिं विभजते ॥

गतिर्द्वेधा सरला वक्रा चेति ॥ १९ ॥

। १ । द्रव्यस्याधःपतनकालिकगतिवदेकदिक्का गतिः सरला । तद्भिन्ना वक्रा ॥

। २ । अथ प्रकारान्तरेण गतिं विभजते ॥

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गतिर्द्वेधा समा विषमा चेति ॥ २० ॥

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। १ । तुल्यकालांशयोस्तुल्यप्रदेशयोरतिक्रमणानुकूला गतिः समा । तद्भिन्ना विषमा ॥

। २ । अथ विषमां गतिं विभजते ॥

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विषमा गतिर्द्वेधा अपचीयमाणा वर्धमाना च ॥ २१ ॥

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। १ । तत्र कस्मिंश्चित् पिण्डे जातगतिकारणीभूतबलविरुद्धदिक्केन सततं प्रवृत्तेन क्रमशस्तदीयवेगक्षयकारिणा बलेन जनिता या गतिः सापचीयमाणा यथा । उत्क्षिप्तपाषाणस्य गतिः पृथिव्याकर्षणहेतोः क्रमेण मन्दतरा भवतीति सापचीयमाणा । तद्भिन्ना वर्धमाना यथा । यदा पतन् पाषाणादिः किंचिद्देशातिक्रमेण कंचन वेगमासादयति तदुत्तरं यदि तस्मिन्नधिकमन्यद्बलं न प्रवर्तेत तर्हि स जडत्ववशात् तुल्येन कालेन तुल्यप्रदेशमतिक्रामेत् । परन्तु तदापि तस्मिन् पृथ्वीकृताकर्षणरूपं बलं प्रवर्तमानमेवास्तीति तस्य वेगः सततं वर्धमानो भवति ॥

। २ । यदा कश्चन बालः स्वहस्तात् कन्दुकं भूमौ पातयति तदा सोऽव्यवहितोत्तरकाले तं कन्दुकं पुनः करेण धर्तुं शक्नोति

परन्तु यदि तन्नृहयो किंचिद्विलम्बः स्यात् तर्ह्यनन्तरं हस्तस्य कन्दुकानुसरणं वृथा भवेत् ॥

। ३ । उन्नताया वृक्षशाखायाः सकाशात् पतदाम्रफलं किंचित्कालं नेत्रेण स्फुटं गोलरूपं द्रष्टुं शक्यते । तेनैव तदवरोहणवृद्धिक्रमोऽपि ज्ञातुं शक्यते । अन्ते तु तत्पतनशैघ्र्यात् केवलं रेखेव भासते ॥

। ४ । बृहद्भाण्डात् कस्मिंश्चिद्द्रवद्रव्ये पातिते तत्पतत्प्रवाहाकार उपरितनप्रदेशादधोभागे स्वावयववेगाधिक्यानुसारेणोत्तरोत्तरं तनुर्भवति । यथानत्युच्चप्रदेशादपि गुडपाके पातिते स पात्रान्निःसरणकाले स्थूलाकारो मन्दगामी भवति । ततस्तलप्राप्तेः प्रागेव स तन्तुरूपो जायते परन्तु स स्वसूक्ष्मीभवनानुसारेण शीघ्रं गच्छन् विलक्षणशैघ्र्येणाधरपात्रं पूरयति ॥

। ५ । ननु पततः पदार्थस्य वेगवृद्धौ भूकृताकर्षणस्य हेतुत्वे गुरौ पाषाण इव लघुनि पत्रेऽपि तस्याविशिष्टत्वात् तेनापि पाषाणतुल्यवेगेन पतितव्यमिति चेत् । सत्यम् । तच्छीघ्रपतनाभावस्तु वायोः प्रतिबन्धादेव । अत एव चात्यन्तगुर्वपि सुवर्णं पत्रीकृतं सच्छीघ्रं न पतति किन्तु वायुना धार्यते ॥

। ६ । अपिच । मुद्रोपरि स्थापितं मुद्रापरिमितं लेखनपत्रं पातितं सत् तया सहैव भुवमागच्छति । वायुकृतस्य लघुपत्रपतनप्रतिबन्धस्य गुर्व्या मुद्रया निरासात् ॥

। ७ । यस्मिन् पात्रे यन्त्रेण वाय्वभावो विहितस्तत्रमुद्रा-पक्षौ समानशीघ्रतयाधो यातः ॥

। ८ । तिर्यक् प्रक्षिप्तः पाषाणः क्रमेणाधो गच्छति पृथिव्याकृष्टेः । तत्र यद्याकर्षणजा गतिः सरित्प्रवाहजगतिरिव समाना स्यात् तर्हि पाषाणः सरित्प्रवाहस्थनौरिव सरलरेखायामेवेयात् । परन्त्वाकृष्टपाषाणाधोगतेर्वर्धमानत्वात् तिर्यक् प्रक्षिप्तः पाषाणः प्रतिक्षणं भिन्नदिशं गच्छतीति तद्गमनं वक्ररेखायां भवतीति प्रत्यक्षसिद्धम् । अस्या वक्ररेखाया आकृतिः शृङ्गकोशनिर्गतजलधाराकृतितुल्या भवति ॥

। ९ । अथ वर्धमानायाः क्षीयमाणायाश्च द्विविधाया विषमगतेरान्दोलकेऽपि प्रत्यक्षदृश्यत्वात् प्रसङ्गतस्तल्लक्षणमाह ॥

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यथा दोलेव पुरः पश्चाद्यायात् तथालम्बितं द्र-
व्यमान्दोलकसञ्ज्ञं स्यात् ॥ २२ ॥

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। १ । स्थिरस्थाननिबद्धयष्ट्यधरप्रान्तालम्बितगोलकविशेषात्मक आन्दोलको लोके प्रसिद्धः ॥

। २ । अथ सूत्रेणालम्बिते पाषाणे येऽनेक आन्दोलकधर्मा लक्ष्यन्ते तेष्वधिकोपयोगमेकं धर्ममाह ॥

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आन्दोलकस्य पुरः पश्चाद्गमनप्रदेशयोर्न्यूनाधिकत्वे

ऽपि कालः समानः ॥ २३ ॥

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। १ । एतद्दर्शनार्थं द्विपञ्चाशदङ्गुलमितसूत्रान्तालम्बितात्प-
पाषाणादिरान्दोलकविशेषः क्रियतां तस्यैकवारमान्दोलनमसु-
पादेनैव भवति। तावति काले सोऽधिकं न्यूनं वा प्रदेशं गच्छतु ।

। २ । एतद्गुणविशिष्टत्वादान्दोलकस्य कालमापन उप-
योगः । प्रसिद्धघटीयन्त्रं केवलमान्दोलक एव भवति । यस्मि-
न्नान्दोलक आन्दोलनसङ्ख्यागणनार्थं चक्राणि योज्यन्ते यत्र च
घर्षणप्रयुक्तगतिरोधस्य वातप्रतिबन्धस्य च दूरी करणाय कश्चन
भारः स्थितिस्थापकविशिष्टं द्रव्यं वा योज्यते ॥

। ३ । अथान्यमान्दोलकधर्ममाह ॥

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आन्दोलकसूत्र दैर्घ्य विशेषात् तदान्दोलनकाल-
विशेषो भवति ॥ २४ ॥

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। १ । आन्दोलकसूत्रं ह्रस्वं चेदान्दोलनमल्पकालेन भवति
दीर्घं चेद्बहुकालेन भवति ॥

। २ । एवं प्रासङ्गिकं परिसमाप्य पुनर्गतिधर्मं निरूपयति ॥

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गतिप्रतिगती मिथस्तुल्ये विरुद्धे च भवतः ॥ २५ ॥

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१ । आकर्षणमुत्सारणं वान्तरेण द्रव्येषु चलनरूपं कर्म

नोत्पद्यत इति तावत् सिद्धम् । तथा च न द्रव्यान्तरसम्बन्धर-
हिते केवले द्रव्य इदं सम्भवति किन्तु मिथः सम्बद्धेषु द्वित्र्यादि-
द्रव्येष्वेव । तेषु च द्वयोर्द्वयोर्मध्ये यद्यप्येकं स्वीयबृहत्वाद्द्रव्यान्त-
रसंयोगजबृहत्वाद्वापरस्मान्मन्दगतिः स्यात् तथापि यथैकमप-
रमाकर्षत्युत्सारयति वा तथैवापरमपि तदाकर्षत्युत्सरायति वेति
बोध्यम् ॥

। २ । यथा यदि कश्चन मनुज एकस्यां नावि स्थित्वापरां
नावं तद्बद्धरज्जोराकर्षणेनाकर्षति तदा ते नावौ मिथः सामी-
प्यमाप्नुतः । तत्र स यामाकर्षति सा तमायाति । यां चारू-
ढोऽस्ति सा तेनाकृष्यमाणां नावं गच्छति । अथ यदि ते नावौ
महत्त्वेन भारेण च मिथः समाने तर्ह्युभावपि समानगत्यैव चल-
तः । यदि च विषमे तर्ह्याकर्षके पुरुषे तयोर्नावोर्मध्ये यां
कांचिदप्यारूढेऽल्पैव नौराशु व्रजति ॥

। ३ । शतघ्न्याख्याग्नेयास्त्रविशेषाद्यदा गोलको निःसरति
तदा गत्युत्पादकं यावद्बलं गोले वर्तते न तावतो न्यूनेन बलेन
शतघ्नी पश्चात् सरति किन्तु शतघ्न्यां वर्तमानस्य गत्युत्पादकब-
लस्य महापिण्डे विस्ताराद्गतिरल्पोत्पद्यते तूर्णं नश्यति च ॥

। ४ । एवं यस्य द्रव्यस्य द्रव्यान्तर आघातो जायते तस्मिन्
तद्द्रव्यान्तरस्यापि प्रत्याघातो जायते । एतावाघातप्रत्याघातौ
समानबलौ मिथो विरुद्धौ च भवतः । स्थितिस्थापकविशिष्ट
द्रव्येष्वयं धर्मो विशेषेण दृश्यते ॥

। ५ । अविषमपृष्ठायां भूमावावर्तितः कन्दुको यदि भित्तौ लम्बरूपेण मार्गेण गत्वा लगति तर्हि स तेनैव मार्गेण परावर्तते । अथ यदि गमनमार्गो भित्तौ लम्बरूपो न स्यात् तर्हि भित्तौ संयोगस्थानात् कृतस्य लम्बस्यैकपार्श्वे यावतान्तरेण स गच्छेत् तावतैवान्तरेणापरपार्श्वे स परावृत्तो भवेत् । यथा समचतुष्कोणगृहस्यैकभुजप्रान्तात् तत्सम्मुखभुजमध्यचिन्हे प्रक्षिप्तः कन्दुकः पूर्वभुजस्यापरप्रान्तं गच्छति । अत एव गमनागमनरेखयोर्लम्बेन सहोत्पन्नौ कोणौ सदा मिथः समानौ भवतः । अत आह ॥

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पतनपरावर्त्तनकोणौ मिथः समानौ ॥ २६ ॥

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। १ । एतावता ग्रन्थेन द्रव्येषु दृश्याः सर्वा गतयः पृथग्भूतानां संयुक्तानां वा परमाणूनां जाड्याभिभवकारके आकर्षणोत्सारणे विना नोत्पद्यन्त इत्युक्तम् । अधुना तदनुसारत एव दृढद्रव्येषु वर्तमानयोः स्थितिगत्योर्विचारः क्रियते ।

। २ । यद्द्रव्यावयवभूताः परमाणवः परस्परं तथा दृढमाकृष्टा भवन्ति यथा तस्यैकदेशे चालिते तत् सकलं द्रव्यं स्वावयवानां परस्परान्तरविकारमन्तरेण चलितं भवति तद्दृढसंज्ञं स्यात् ॥

। ३ । तत्र प्रथमं दृढतायाः फलमाह ॥

दृढद्रव्यस्यैकदेशं चालयद्बलं सकलं द्रव्यं चालय-
ति । अथवा तदेकदेशं तस्मात् पृथक् करो-
ति ॥ २७ ॥

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। १ । मृण्मयं पात्रं ग्रीवैकदेशं धृत्वोत्थापयितुं शक्यते । तेनेदं सिध्यति यत् पात्रभारात् तत्परमाणूनां संयोगो बलवा-नस्तीति । परन्तु यदि पात्रमुक्तप्रकारेण सहसोत्थाप्येत तदा ग्रीवैकदेशः पात्रात् पृथग्भविष्यति पात्रं चाधः पतिष्यति । पात्रगतजाड्यभारयोः परमाणुसंयोगविभागसमर्थत्वात् ॥

। २ । अथान्यद्दृढतायाः फलमाह ॥

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प्रत्येकं सर्वस्मिन् पदार्थे संयुक्तकतिपयपदार्थसमु-
दाये च गुरुत्वकेन्द्रसंज्ञकः कश्चिद्बिन्दुर्वर्तते यं परि-
तः सर्वेषां तदंशानां समतुलत्वं भवति ॥ २८ ॥

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। १ । तथाहि । यदि सरला काष्ठादियष्टिस्तुलादण्ड इव मध्यदेशेऽवलम्बितः स्यात् तर्हि तस्य प्रान्तौ परस्परं तुलयतः । अथ तत्प्रान्तयोस्तुल्यभारसंयुक्तयोः सतोरपि समतुलत्वं विकृतं न भवति । तादृशयष्टेर्मध्यदेशो गुरुत्वकेन्द्रसंज्ञकः । इदं गुरु-त्वकेन्द्रं प्रतिद्रव्यं भवति ॥

। २ । तस्मिन् बिन्दौ साधारे सति पदार्थो न पतति । यदि स बिन्दुर्निराधारः स्यात् तर्हि यस्मिन् पार्श्वे तेन स्थीयते

तस्मिन्नेव पार्श्वे तद्द्रव्यं पतति । यथा समानस्य काष्ठदण्डस्य गुरुत्वकेन्द्रं मध्य एव वर्तते । अतस्तस्मिन् बिन्दावङ्गुल्यादिनावलम्बिते दण्डः स्थिरो भवति । अथाधारस्य यस्मिन् पार्श्वे स बिन्दुः स्यात् तस्मिन्नेव पार्श्वे स दण्डः पतेत् ॥

। ३ । गुरुत्वकेन्द्राद्भूपृष्ठे यो लम्बः स गुरुत्वलम्बसंज्ञः स्यात् । पदार्थो भूपृष्ठे यावन्तं देशमभिव्याप्य वर्तते तद्देशाद्बहिस्तद्गुरुत्वलम्बो न पतेच्चेत् तद्द्रव्यं तिष्ठेदन्यथा पतेत् ॥

। ४ । यदाल्पनौस्था जना उत्तिष्ठन्ति तदा नौसहिततदन्तर्वर्तिजनस्य गुरुत्वकेन्द्रमप्युत्तिष्ठति । अतस्तदाल्पतरेणापि नौस्थितिविपर्ययेण गुरुत्वलम्बो बहिः पतति । तेन च नौमज्जनं प्रसज्येत । अतस्तदन्तर्वर्तिनः सर्व एव जना युगपन्नोत्तिष्ठेयुः ॥

। ५ । गोलस्य गुरुत्वकेन्द्रं गोलकेन्द्र एव वर्तते । अतः समान भूभागे यत्र कुत्रापि स्थितो गोलः स्थिरो भवति यतस्तद्भूसंयोगबिन्दावेव तद्गुरुत्वलम्बः पतति परं क्रमनिम्नभूभागे स्थापितस्य गोलस्य गुरुत्वलम्बो न कदाचन गोलभूसंयोगबिन्दौ पततीति स गोलोऽधो गच्छति ॥

। ६ । किञ्च द्रव्यमात्रस्य गुरुत्वकेन्द्रं तद्द्रव्य एव वर्तत इति न नियमः । यतः कङ्कणादिपदार्थानां गुरुत्वकेन्द्रं तन्मध्यस्थावकाशे वर्तते तज्ज्ञानप्रकारश्चायम् । कङ्कणपालेः कस्मिंश्चित् स्थाने निबद्धेन सूत्रेण कङ्कणं लम्बयेत् । ततस्तत्स्थाननिबद्धमपरसूत्रं तत्स्थानलम्बदिकस्थे पालिप्रदेशे बध्नीयात् । एवं पाले-

रन्यस्मिन् स्थाने निबद्धेन सूत्रेण कङ्कणं लम्बयित्वा सूत्रान्तरं पूर्ववद्विधीयात् । तथा सति तयोर्द्वयोः सूत्रयोः कङ्कणमध्यावकाश यत्र स्थाने संपातस्तत्रैव कङ्कणस्य गुरुत्वकेन्द्रम् । यतस्तस्मिन्नेव साधारे कङ्कणावयवानां समतुलत्वं भवति ॥

। ७ । पूर्वोक्तेभ्यो द्रव्यधर्मेभ्यो गतिधर्मेभ्यश्च मनुष्यक्लेश-लाघवायात्युपकारकाणि यन्त्राणि निर्मातुं शक्यन्ते ॥

। ८ । अथान्यदृढतायाः फलमाह ॥

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यस्मिन् कस्मिंश्चिद्दृढद्रव्ये स्वाक्षं परितश्चक्रवत्
तुलादण्डवद्वा भ्रमिते तस्य सर्वेषामवयवानां के-
न्द्रादक्षाद्वा यथा यथा दूरत्वं तथा तथा गत्या-
धिक्यम् ॥ २९ ॥

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। १ । एष धर्मः कुलालचक्रभ्रमिदर्शनेन स्फुटमवगम्यते । तथाहि । भ्रमतश्चक्रस्य प्रान्ते निहित आर्द्रमृत्पिण्ड एकस्मिन् पर्यये तच्चक्रकेन्द्रपरिधिमध्यनिहिततादृशपिण्डातिक्रान्तप्रदेशा-द्विगुणं प्रदेशमतिक्रामति ॥

। २ । अथान्यदृढतायाः फलमाह ॥

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असिमभारावपि पदार्थौ समतुलौ भवितुमर्हतः ।
यदि तदुभयसम्बन्धकारकं दृढद्रव्यं तथा विन्यस्तं
स्याद्यथाल्पस्य भारान्महतो भारो यद्गुणोऽधिक-

स्तद्गुण एव महतो गतेरल्पस्य गतिरधिकः
स्यात् ॥ ३० ॥

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। १ । एष एव सिद्धान्तः सकलयन्त्रनिर्मितिशास्त्रस्य मूलं भवति । अनेनैवोत्तोलनदण्डादीनि यन्त्राणि निर्मितानि भवन्ति यद्द्वारा शिल्पी यद्यद्बलं जगति प्राप्नोति तदिष्टकार्ये योजयितुं शक्नोति ॥

। २ । तत्र धातुकाष्ठादिनिर्मितः समानस्थौल्यविशिष्टो दण्ड उत्तोलनदण्ड इत्युच्यते ॥

। ३ । यद्युत्तोलनदण्डमध्य आधारे स्यात् तर्हि तस्य द्वौ भुजौ समतुलौ स्याताम् । तदग्रयोः समभारपदार्थयोजनेऽपि तयोः समतुलत्वं न हीयते । अनयैव युक्त्या व्यवहारे पदार्थगुरुत्वमापनार्थं तुलयन्त्रं क्रियते ॥

। ४ । यद्युत्तोलनदण्डतृतीयांशचिह्नमाधारे स्यात् तर्हि यस्मिन् पार्श्वे दण्डस्य द्वौ तृतीयांशौ वर्तेते तत्र गुरुत्वकेन्द्रं स्यात् तदा दीर्घभुजप्रान्तलग्नो भारः स्वद्विगुणेन ह्रस्वभुजप्रान्तलग्नभारेण समतुलः स्यात् । अतो यस्मिन् तुलायन्त्रे दण्डस्य भुजौ विषमौ स्यातां तत् क्रयविक्रयकाले छलार्थमुपयुज्यत इति स्पष्टम् ॥

। ५ । यदि दण्डस्य चतुर्थांशचिह्नमाधारे स्यात् तर्हि दीर्घभुजप्रान्तलग्नभारः स्वस्माच्चतुरादिगुणेन ह्रस्वभुजप्रान्तलग्न-

भारेण समतुलः स्यात् । अपि च । समतुलत्वावस्थायां यदि दीर्घभुजप्रान्तलग्नो भारो लेशेनापि वर्धितः स्यात् तर्हि तत् ह्रस्वभुजप्रान्तलग्नं महान्तमपि भारमुत्थापयेत् । अतो यदतिगुरु नानेकजनहस्तैरुत्थापयितुं शक्यते तदुत्तोलनदण्डोपायेनैकोऽपि मनुज उत्थापयितुं शक्नोति ॥

। ६ । यावता कालेन ह्रस्वभुजप्रान्तलग्नो भारोऽल्पदेशमतिक्रामति तावतैव दीर्घभुजप्रान्तलग्नभारो महान्तं देशमतिक्रामति । एवं चोत्थापकबले यावल्लाघवं तावद्वेोत्थापनकाले गौरवमिति प्रत्यक्षम् । एतच्च न केवलमुत्तोलनदण्डविषये किन्तु यन्त्रमात्रे । नचैतावता यन्त्राणामकिञ्चित्करत्वम् । यतो यत्कार्यं शरीरबलसहस्रेणाप्यसम्भाव्यं तच्चेत् कालाधिक्येन संपद्येत तर्हि स महालाभो ज्ञेयः ॥

। ७ । यत्र सरित्प्रवाहजं वातप्रवाहजं वा तप्ततोयवाष्पविस्तृतिजं वा बलं गमने हेतुर्भूत्वोपतिष्ठते तत्र मनुष्यस्तद्बलं यन्त्रोपायेन वशीकृत्य तेन स्वसेवकवत् कर्म कारयितुं कल्पते । इदं यन्त्राणामधिकं फलं ज्ञेयम् ॥

। ८ । इति द्रव्यीयगतिस्थितिविचारः ॥

। ९ । अथ ज्योतिर्गतिविचारे प्रथमं निरूपितानां खस्थपिण्डगतीनां कारणानि गतिसामान्यकारणनिरूपणप्रसङ्गान्निरूपयितमारभते ॥

। १ । तत्रादौ चन्द्रस्य भुवं परितो भ्रमणे कारणमाह ॥

चन्द्रः स्वगत्यनुकूलजाड्याद्भूमेराकर्षणाच्च भुवम-
भितो भ्रमति ॥ ३१ ॥

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। १ । स्वगत्यनुकूलेत्यादि । यथा यदा दूरे वर्तमानः कश्चन मनुजः स्वहस्तं भ्रामयन् तत्परितः कन्दुकश्च भ्राम्यन् दृश्यते तदा दूरत्वादिकारणात् तद्धस्तकन्दुकयोर्मध्ये स्थितायां रज्ज्वामदृश्यायामपि तत्र रज्ज्वादिसंयोजकावश्यंभावोऽनुमीयते तथा चन्द्रस्य चक्रभ्रमणे जाड्यानुकूलसरलगमनप्रतिबन्धकं किंचन बलान्तरमनुमीयते । एकेनैव बलेनासरलगमनासम्भवात् । तदेव भूमिकृताकर्षणमिति ॥

। २ । ननु सर्व एव पिण्डाः पूर्वोक्तयुक्त्या परस्परमाकर्षन्तीति चन्द्रोऽपि भुवमाकर्षति तथा सति भूरेव चन्द्रमभितः कुतो न भ्रमतीति चेत् । उच्यते । मिथः सम्बद्धयोः पिण्डयोराकाशे भ्रमतो र्भ्रमणं तत्साधारणगुरुत्वकेन्द्रमभितो भ्रमति । तद्गुरुत्वकेन्द्रं च प्रत्येकस्मात् पिण्डादपरद्रव्यांशप्रमाणान्तरे वर्तते । एतच्च सरलयष्ट्याः प्रान्तयोर्गोलपिण्डौ संयोज्य तादृशयष्ट्यामाकाश उत्क्षिप्तायां तयोर्गोलयोर्भ्रमणतः प्रत्यक्षम् । तत्र पिण्डयोरेको यथा यथा परस्मान्महान् स्यात् तथा तथा गुरुत्वकेन्द्रं महापिण्डनिकटं भवेत् । तथाच यदा साधारणगुरुत्वकेन्द्रं महापिण्डान्तर्गतं स्यात् तदा तयोः साधारणगुरुत्वकेन्द्रमभितो भ्रमणे महापिण्डमभित एव लघुपिण्डभ्रमणं भवेत् ।

एवं भूमिचन्द्रौ परस्पराकृष्टिसम्बद्धौ प्रत्येकमेकस्मादपरद्रव्यांशप्रमाणान्तरे वर्तमानं स्वसाधारणगुरुत्वकेन्द्रमभितो भ्रमतः। तत्र चन्द्रद्रव्यांशेभ्यो भूद्रव्यांशानां शतगुणत्वाद्भूचन्द्रयोः साधारणगुरुत्वकेन्द्रं भूगोलान्तर्गतं भवति तदभित उभयोर्भ्रमणे भुवमभित एव चन्द्रस्य भ्रमणं भवति ॥

। ३ । अथैतदेव भूम्यादिग्रहेष्वतिदिशति ॥

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एवं भूर्बुधादयो ग्रहाश्च स्वजाड्याद्रवेराकर्षणाच्च
रविं परिभ्रमन्ति ॥ ३२ ॥

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। १ । एवमिति । यथा भूचन्द्रयोः स्वसाधारणगुरुत्वकेन्द्रमभितो भ्रमणे चन्द्रमपेक्ष्य पृथिव्या अतिपृथुत्वाच्चन्द्रस्य भुवमभित एव भ्रमणं भवति तद्वत् सूर्यभूमिबुधादीनां तत्साधारणगुरुत्वकेन्द्रमभितो भ्रमे भुवं बुधादीन् ग्रहांश्चापेक्ष्य सूर्यस्यातिमहत्त्वात् साधारणगुरुत्वकेन्द्रस्य सूर्यपिण्डान्तर्गतत्वात् भूर्बुधादयः सर्वे ग्रहाश्च रविं परित एव भ्रमन्तीति । अनयैव युक्त्या सर्वे उपग्रहाश्च स्वं स्वं ग्रहं परितो भ्रमन्तीत्युपपद्यते ॥

। २ । अथ जलादिद्रवद्रव्याणां धर्मा उच्यन्ते ॥

। ३ । द्रवपदार्था निजकणानां सङ्घट्टनाल्पत्वात् न पर्व-

वत् राशीभवन्ति किन्तु गुरुत्वाकर्षणवशात् पतन्ति । एतद्धर्म-कथनार्थं सूत्रम् ॥

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द्रवपदार्था सदा समानपृष्ठा भवितुमर्हन्ति ॥ ३३ ॥

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। १ । तत्कणानां गुरुत्वप्रयुक्तमधःपतनं निरपेक्षमस्तीति सर्वतस्तेषां मिथःपीडनम्भवति । ऊर्ध्वभागे यत्तेषाम्पीडनं तत् गुरुत्वविरुद्धं नास्ति किन्तु अधःपीडनप्रयुक्तन्तत् ॥

। २ । यथा । यदा नालविशिष्टे पात्रे जलम्प्रक्षिप्यते तदा किञ्चिज्जलं नालान्तरमारुह्य प्रांशुत्वेन पात्रस्थतोयसमम्भवति पात्रतले स्थिता जलकणा उपरिस्थितजलकणैः पीडितासन्तो यत्र निःसरणमार्गः स्यात् तेन गच्छन्ति । इह निःसरणमार्गो नाल एव प्राप्यते तैः । अतस्तैस्तत्र गम्यते ॥

। ३ । एवं जलधर्मं ज्ञात्वा समीपपर्वतकन्दरे जलाशयं च विलोक्य दीर्घं लोहनालं तत्र संयोज्य तद्द्वारा तज्जलं स्वनगर अत्युच्छ्रितगृहाणामुपरिभागमपि नेतुं शक्यते । युरोपाख्यदेश-वर्त्तिनगरेषु अयं महोपकारको जलप्रापणोपायः क्रियते । अत्र तज्जलाशयस्थानेन नगरस्थानादवश्यं उच्छ्रितेन भवितव्यं यतो मूलस्थानादुच्चतरस्थाने नालद्वारा जलं न गच्छति यथा नाल-विशिष्टपात्रे दृश्यते ॥

। ४ । अथ जलस्य जातीयगुरुत्वमापकत्वमुच्यते ॥

द्रव्याणां जातीयगुरुत्वस्य निर्णयाय जलं मापकं क्रियते ॥ ३४ ॥

। १ । जातीयगुरुत्वं सदा सापेक्षं भवति यथा लोहमपेक्ष्य कर्करो जात्या लघुरस्ति किन्तु काष्ठमपेक्ष्य गुरुर्भवति ॥

। २ । तच्च गुरुत्वमेवं निर्णीयते । पदार्थस्य सामान्यरूपेण गुरुत्वं विज्ञाय पश्चात् तज्जले स्थापयित्वैतद्गुरुत्वन्यूनता निश्चेतव्या तदा गणितेन तस्य जातीयगुरुत्वं झटिति ज्ञायते ॥

। ३ । यथा । किञ्चित्सुवर्णखण्डमेकोनविंशतिपलमितमस्तीति ज्ञात्वा जले स्थितं तत्खण्डमष्टादशपलमितम्भवति । इति जानीयात् । ततस्तत्खण्डदेशे स्थितं जलम्पलमितं स्यात् इत्यनुमाय सुवर्णस्य जातीयगुरुत्वं जलगुरुत्वमपेक्ष्य एकोनविंशतिगुणं स्यादिति बोध्यम् ॥

। ४ । यस्य पदार्थस्य जातीयगुरुत्वं ज्ञातव्यं स जले क्षेप्यः तदा यदि यावत्स जले मग्नस्तत्रैव तिष्ठेत् नाधो गच्छेत् तदा तस्य जातीयगुरुत्वं जलगुरुत्वेन तुल्यं ज्ञेयं यतो यस्य जलांशस्य स्थाने स पदार्थः स्थितः स जलांशो यावता बलेन पूर्वमवलम्बितस्तावतैव बलेन तत्तुल्यगुरुत्व एव पदार्थोऽप्यवलम्बितः स्यात् ॥

। ५ । यः कोऽपि पदार्थो जले प्रक्षिप्तः सन् स्वगुरुत्वपरिमितजलं अन्यत्र कृत्वा स तत्र तिष्ठति परं यदि तन्महत्त्वं तद्गु-

रुत्वमितजलमहत्त्वादधिकं स्यात् । यथा । मृत्पिण्डः जले क्षिप्तः सन् मज्जेदेव यतस्तन्महत्त्वं स्वगुरुत्वमितजलमहत्त्वादूनं भवति परं स एव घटीकृतः तरति यतः स्वगुरुत्वमितमेव जलमन्यत्र करोति स्वगुरुत्वमितजलमपेक्ष्य स्वमहत्त्वस्याधिक्यात् ॥

। ६ । एवं नौः स्वभारानुसारेण जले किञ्चिन्मज्जति । तथा लोहनिर्मिता नावोऽपि तरन्ति । गङ्गायां या बाष्पीयनावो दृश्यन्ते ता लोहनिर्मिता एव सन्ति ॥

। ७ । यस्य पदार्थस्य जातीयगुरुत्वं जलगुरुत्वान्न्यूनं स्यात् तस्य जले मज्जनाभावात्तज्जातीयगुरुत्वं कथमवगन्तव्यमित्येतदर्थन्तस्मिन् लघुपदार्थे ऽवगतजातीयगुरुत्वो गुरुपदार्थस्तथा संयोज्यो यथा स लघुपदार्थो जले मज्जेत् ॥

। ८ । जलादीनां स्थितिस्थापकोऽत्यल्पोऽस्ति । द्रवीभूतानां साधारणवाय्वादीनाम् महानित्युच्यते । अथ वाय्वादिधर्मकथनमारेप्सुः सूत्रयति ॥

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जलादिकात् वाय्वादिकस्य मुख्यो विशेषः स्वस्थितिस्थापकः ॥ ३५ ॥

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। १ । स्वस्थितिस्थापक इति । अतिबलेन पीडने वाय्वंशस्य परिमाणमत्यल्पं भवति तत्पीडनस्यापसरणमात्रे तु स वाय्वंशो झटिति यथापूर्वं विस्तृतो भवति ॥

२ । स्थितिस्थापकत्वाद्वायुः सर्वतः पीडयति ॥

। ३ । अथ वायुजलयोस्समानो धर्म उच्यते ॥

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वायुर्गुरुरस्ति ॥ ३६ ॥

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। १ । अत्र प्रमाणान्युच्यन्ते ॥

। २ । वायोर्गुरुत्वादेव द्रवरूपाः पदार्था नलद्वारा मुखेन आक्रष्टुं शक्याः । यथा । नलस्यैकमग्रं जलान्तः कृत्वा द्वितीयं वक्त्रे धृत्वा उरःस्थानं विस्तारयेत् तदा तत्स्थानं विशालं भवति तत्रत्यो वायुश्च स्थितिस्थापकविशिष्टत्वाद्विस्तृतो भूत्वा लघुर्भवति अतो यावता बलेन जलं पीडितम्भवति न तावता नालाग्रस्थितमिति तज्जलम्बहिः पीडनेन नालान्तः उपरि गच्छति ॥

। ३ । उपयुक्तयन्त्रेण पात्रान्तर्गतं वायुं निष्काश्य तद्वायुरिक्तपात्रस्य गुरुत्वं निर्णीय पुनर्वायुपूर्णस्य तत्पात्रस्य गुरुत्वं निश्चीयते तथाच तद्गुरुत्वयोर्भेदात्तत्पात्रमितवायोर्गुरुत्वं ज्ञायते ॥

। ४ । वायोर्जातीयगुरुत्वं जलगुरुत्वस्य अष्टशततमांशमितं भवति यतो यत्पात्रस्य वायुपूर्णस्य गुरुत्वं तस्यैव वातरिक्तस्य गुरुत्वात् माषेणाधिकं तस्मिन्पात्रे अष्टशतमाषमितं जलन्तिष्ठतीति प्रत्यक्षम् ॥

। ५ । भूमेरूर्ध्वं द्वाविंशतिक्रोशपर्यन्तं सामान्यवायुः वर्त्तते

इत्यनेकैर्हेतुभिरनुमीयते। वायोरुपरितनभागैरधःस्थिता भागाः पीडिता अतस्ते घनाः सन्ति। उपरितनाश्च शिथिलीभवन्ति। अत्युच्छ्रितपर्वतशिखरे वायोः शैथिल्यात् निःश्वासकरणं दुर्घटम्भवति ॥

। ६। वातगुरुत्वमापकसंज्ञकयन्त्रेण पर्वतस्योच्छ्रायोऽवगन्तुं शक्यते ॥

। ७। अथ तद्यन्त्रनिर्माणविधिः। द्विहस्ताधिकदैर्घ्यविशिष्टमेकमुखङ्काचनालम्पारदेन पूरयित्वा तन्मुखमङ्गुल्या रुद्धा तलमुपरि विधाय पात्रान्तर्गतपारदे स्थापयित्वा अङ्गुलीन्निष्कासयेत् तदा नालवर्तिपारदः किञ्चिदधो यास्यति नालतले किञ्चित्स्थानं रिक्तम्भविष्यति यत्र वायुर्गन्तुं न समर्थः पात्रस्थपारदनिवारणात्। अतस्तत्स्थानस्य रिक्तत्वान्नहि नालवर्तिपारदः सामान्यवायुना पीडितो भवति। अतो नलस्थः पारदः सामान्यवायुपीडितेन पात्रस्थपारदेनावलम्बितो वर्तते। अतो यत्र यदाच वायोर्गुरुत्वमधिकं स्यात् तत्र तदाच नालवर्तिपारदस्योच्छ्रता अधिका दृश्यते ॥

। ८। सामान्यतस्तस्योच्चता एकोनचत्वारिंशदङ्गुलपरिमिता भवति। यदि तद्यन्त्रम्पर्वतशिखरे वा उच्चगृहोपरिभागे वा नीयते तदा उपरितनवायोः शिथिलत्वात् तद्गुरुत्वपीडनस्याल्पत्वात् नालवर्तिपारदोऽधोगच्छति। एवमनेकवारं परीक्ष्य नालवर्तिपारदस्याधरीभवनज्ञानेन पर्वतोत्सेधस्य ज्ञान-

भवेदिति निश्चित्याऽधुना तत्कर्मणि तद्यन्त्रमुपयोजितम् ॥

। ९ । स नालस्थपारदो झञ्झानिलागमनात्पूर्वमपि किंचिदधो गच्छति । अत इदं झञ्झावातागमज्ञापकं यन्त्रम् महासागरगन्तृनाविकानामत्युपकारकम्भवति ॥

। १० । अथ यावता वातपीडनेन रस एकोनचत्वारिंशदङ्गुलमितदैर्घ्यविशिष्टोऽवलम्बितस्तावता यस्य जातीयगुरुत्वम्पारदगुरुत्वादल्पम्भवति स अधिकदैर्घ्यविशिष्टोऽवलम्बितो भवेत् इत्यनुमीयतां । यथा । जलगुरुत्वमपेक्ष्य पारदगुरुत्वं सार्द्धत्रयोदशगुणं भवति यावत्तत्संख्यया तन्नालवर्तिपारदोच्चत्वमितिर्हन्यते तावत् द्वाविंशतिहस्ता लभ्यन्ते प्रत्यक्षेणापि तन्नाले जलस्योच्छ्रितिस्तावत्येव दृश्यते ॥

। ११ । अथ द्वयोरन्योन्यामिश्रणशीलयोः जलपारदादिद्रवपदार्थयोः तुल्यगुरुत्वांशप्रमाणज्ञानार्थं युक्तिरुच्यते । अङ्कुशाकारा वक्रा काचनली ऊर्ध्वाग्रा धार्या ततस्तन्नल्यग्रयोस्तौ पदार्थौ तावत्तथा क्षेप्यौ यावद्यथा तन्नलीमध्यभाग एव तयोः संयोगो वर्तेत तदा तयोः पदार्थयोः स्वस्थानदेशांशप्रमाणे विपर्ययेण तुल्यगुरुत्वांशमाने ज्ञेये । यथा । पानीयपारदयोः उक्तविधिना नल्यां क्षिप्तयोरेकाङ्गुलदेशवर्तिपारदः सार्द्धत्रयोदशांगुलदेशवर्तिपानीयेन मध्यचिह्न एवावलम्बते । अतः पानीयगुरुत्वमपेक्ष्य पारदगुरुत्वं सार्द्धत्रयोदशगुणम्भवति ॥

। १२ । अथेदं यन्त्रमधराग्रं यदा ध्रियते तदा तत्कुक्कुट-

नाडीयन्त्रमुच्यते । इदमुपकारकं कुक्कुटनाडीयन्त्रम्भास्कराचार्यैः स्वशिरोमणिमिताक्षरायां यन्त्राध्याये वर्णितम् । तथाहि । ताम्रादिधातुमयस्य अङ्कुशरूपस्य वक्रीकृतस्य नलस्य जलपूर्णस्य एकमग्रं जलभाण्डे अन्यदग्रं बहिरधोमुखञ्चैकहेलया यदि विमुच्यते तदा भाण्डजलं सकलमपि नलेन बहिः क्षरति । तद्यथा छिन्नकमलस्य कमलिनीनलस्य जलभृद्भाण्डे क्षिप्तस्य जलपूर्णसुषिरस्य एकमग्रं भाण्डाद्बहिरधोमुखंद्रुतं यदि भ्रियते तदा भाण्डजलं सकलमपि नलेन बहिर्याति । इदङ्कुक्कुटनाडीयन्त्रं शिल्पिनां हरमेखलिनाम्ना प्रसिद्धमनेन बहवश्चमत्काराः सिध्यन्तीति ॥

। १३ । एतद्यन्त्रकर्मापि वातगुरुत्वेनैवोपपद्यते । तद्यथा । भाण्डस्थतद्यन्त्रार्द्धान्तर्गतजलमपेक्ष्य बाह्यार्द्धान्तर्गतजलस्य गुरुतरत्वाद्बाह्यभागस्थं जलम्बहिः पतितुमारभते । तेनापरार्द्धं नलो रिक्तो भवितुमारभत अतस्तस्मिन्प्रदेशे सामान्यवायुगुरुत्वपीडितं पात्रस्थञ्जलमुत्तिष्ठत इति ॥

। १४ । वायुः शब्दस्य मुख्यो वाहको भवति । अन्येऽपि पदार्थाः शब्दस्य वाहकाः सम्भवन्ति । अत्र सूत्रम् ॥

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कर्णसंयुक्तवाय्वादौ अत्यन्तशैघ्र्येण स्पन्दनमुत्पद्यमानं शब्दप्रत्यक्षकारणम् ॥ ३७ ॥

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। १ । वाय्वादाविति । जलस्याधोभागेऽपि जाता घण्टा-रवः श्रूयते ॥

। २ । एवमद्रवपदार्था अपि शब्दवाहका भवन्ति । यथा लोहदण्डाग्रं सूत्राभ्याम्बद्ध्वा तत्सूत्राग्रे कर्णसंयुक्तेच कृत्वा तल्लो-हदण्ड अपरलोहदण्डेन हन्यताम् । तदा तत्सूत्रद्वारा य-च्छब्दप्रत्यक्षं जायते तादृशं वायुद्वारा न भवति ॥

। ३ । घण्टादिकठिनपदार्थस्य वादनेन तत्रात्यन्तशीघ्रेण स्पन्दनमुत्पद्यते तत्स्पन्दनेन हतो वायुरपि स्पन्दितो भूत्वा कर्णान्ताडयति तदा शब्दप्रत्यक्षं जायते ॥

। ४ । वाय्वादिरहितपात्रस्था घण्टा वादितापि शब्दं न करोति ॥

। ५ । जलाशये पाषाणप्रक्षेपेण पतनस्थानमभितोऽल्प-स्तरङ्ग उत्पद्य क्रमशः प्रसरति । तस्य संलग्नतया परितोव-र्तिनि जलेऽन्येऽपि तरङ्गास्तथैवोत्पद्यन्ते । एवं यथा ते तरङ्गाः क्रमशः प्रसरन्ति तद्वद्वायवर्त्तिनोऽपि स्पन्दनोत्पन्नास्तरङ्गाः सर्वतः प्रसरन्ति ॥

। ६ । दूरस्थो रजको वस्त्रेण प्रस्तरन्ताडयति तदा किञ्चि-त्कालेनाघातशब्दः श्रूयते । तेनेदमनुमीयते । सूत्रम् ॥

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प्रतिप्राणपादं शब्द एकषष्ट्युत्तरसप्तशतहस्तमि-
तदेशं वायौ गच्छति ॥ ३८ ॥

। १ । शब्दगमनस्य शैघ्र्यं ज्ञात्वा शब्दहेतोर्दूरत्वमनुमातुं शक्यते । यथा । यदि विद्युल्लतान्दृष्ट्वा त्रिंशत्प्राणपादान्तरेण मेघध्वनिः श्रूयेत तदा क्रोशत्रयादधिकदूरे मेघो नास्तीति अनुमीयते ॥

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वायुतरङ्गपुनरागमनात् प्रतिध्वनिर्जायते ॥ ३९ ॥

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। १ । जलाशय उत्पन्नास्तरङ्गास्तीरं हत्वा परावर्तन्त इति दृश्यते । तद्वत् स्पन्दनोत्पन्ना वायुतरङ्गा अपि पर्वतगृहादिकं समानरूपं पदार्थं हत्वा पुनरायान्ति । तदा ज्ञातः शब्दः प्रतिध्वनिरुच्यते । अयं शब्दः पर्वतादागत इति कर्णेन बुध्यते यथा दर्पणे प्रतिबिम्बं दृष्ट्वा दर्पणपाश्चात्यभागे इदं वर्तत इति नेत्रेण बुध्यते ॥

।२। तद्वत् यदि लम्बदिशि तरङ्गाणामाघातः स्यात्तदा गमनागमनरेखयोरैक्यं भवेत् नो चेन्न कथमन्यथा पतनपरावर्तनकोणयोः समत्वम् ॥

। ३ । यथा द्रवाद्रवपदार्थानामाकर्षणजं गुरुत्वमस्ति तथा वायोरपीति सिद्धम् । परन्तु उत्सारणमुख्यकारणीभूताया उष्णताया गुरुत्वं नास्तीत्यनुमीयते मानाभावात् यद्यपि तस्यामनेके वाय्वादिकस्य धर्माः सन्ति ॥

। ४ । अथ गुरुत्वरहितपदार्थानामुष्णतादीनां विचारः ॥

उष्णताधर्मो धर्मिणः कदापि न पृथक् दृश्यते नच तत्र गुरुत्वजडत्वयोः प्रमाणमस्ति ॥ ४० ॥

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। १ । अयोगोलस्तप्तो ऽपि गुरुतरो न भवति ॥

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समीपवस्तून्युष्णतां समतया विभजन्ति ॥ ४१ ॥

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। १ । यथा । तप्तायोगोले जलपूर्णपात्रे प्रक्षिप्ते सति अयोगोलः शीतो भवति जलन्तु उष्णम्भवति ॥

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यत्र उष्णताया न्यूनता तत्र शैत्यमिति व्यवहारः ॥ ४२ ॥

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। १ । यथा । एकेन हिमालयप्रस्थादागतेन तथैकेन मध्यदेशाद्गतेनचार्द्धपथङ्गताभ्यामुभाभ्यां मिथो व्यतिसंवादे अहो अत्युष्णो ऽत्र वायुरहो अतिशीतो ऽत्र वायुरिति न तत्र प्रत्यक्षं प्रमाणं तत्तत्पुरुषपूर्वानुभूतवायूष्णतान्यनाधिकभावानुसार्यनुभवभेदेन ॥

। २ । किञ्च । यथात्र जनभेदेनोष्णताशैत्यविसंवादस्तथा जनैक्ये ऽपि पूर्वानुभूतोष्णशीतपदार्थधृतयोः करयोरनुष्णाशीतजले युगपत्प्रवेशेचैकेन करेणातिशीतमिदं जलमिति एकेनच

करेणात्युष्णमिदं जलमिति चानुभवदर्शनाच्च न मनुष्यमात्रेणो-
ष्णतामापनं किन्तूपायान्तरेणेति ज्ञेयम् ॥

उष्णतया पदार्थो विस्तृता भवन्तीति यस्य पदा-
र्थस्य विस्तरक्रमो मातुं शक्यते स पदार्थ उष्ण-
तामापकः सम्भवति ॥ ४३ ॥

। १ । अथ साधारणस्य उष्णतामापकस्य निर्माणविधिः ।
काचनलिकासहितकाचगोलं पारदेन जलादिना वा पूरयेत्
तर्हि यदा उष्णतावृद्धिर्भवेत्तदा पारदादिद्रवपदार्थः क्रमेण
विस्तृता भूत्वा नलिकायामुपरि गत्वा उष्णतावृद्धिक्रमं द्योत-
यति ॥

पदार्थविशेषेण तत्रोष्णताया गमनशैघ्र्य-
विशेषः ॥ ४४ ॥

। १ । तद्यथा । अङ्गुलीभिर्धृतं ज्वलत्तृणं यावदङ्गुलिनिकटे
न ज्वलेत्तावदङ्गुलीषु नोष्णताप्राप्तिर्भवेत् । धात्वादिषु त्वति-
शीघ्रमेवोष्णता तद्द्वारा चलति । यथा । लोहसूत्रस्यैकस्मिन्
भागे ऽङ्गुलीभिर्धृते ऽपरस्मिंश्चाग्नौ निवेशिते ऽत्यल्पेनैव काले-
नाङ्गुलीषूष्णताप्राप्तिः ॥

शून्यमार्गद्वाराप्युष्णता गन्तुं शक्नोति ॥ ४५ ॥

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। १ । तत्र किरणरूपा उच्यते ॥

। २ । तप्तायोगोलकात्सर्वतः सरलरेखाभिस्तेजो गच्छति । पतनपरावर्त्तनकोणयोः साम्यं धर्म उष्णताया अपि । अतो यदा सरलरेखाभिस्समागता रविकिरणा मध्यनिम्ने दर्पणे पतन्ति तदा पतन्परावर्तनकोणयोः साम्यात् मध्यदिशि युक्तस्थले तावति दूरे विन्यस्तमन्नं पक्वम्भविष्यति ॥

। ३ । रात्रौ पदार्थाः शीतला भूत्वा प्रालेयवन्ति भवन्तीत्येतत् किरणरूपेणोष्णताया निर्गमस्य फलं । इदं च द्वितीये ऽध्याये प्रदर्शितम् । एनमेव कार्यकारणभावमाश्रित्योत्तरपाश्चिमे भारतवर्षभागे शीतकालीनासु मेघरहितासु रात्रिषु जलं घनीकृत्योष्णकालोपयोगाय हिमरूपेण लोकैः सङ्गृह्यते । तथाहि घनीचिकीर्षितजलपूर्णानि पात्राणि शुष्कतृणानामुपरि निधीयन्ते तेन च किरणरूपेण जलान्निर्गच्छन्त्या उष्णतायाः स्थाने भूमिगतोष्णता यातुं न शक्नोति तृणानामुष्णताद्वारत्वाभावात् ॥

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घर्षणेनोष्णतायाः प्रादुर्भावः सम्भवति ॥ ४६ ॥

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। १ । एवं हि यदा द्रव्याणि घृष्यन्ते तदा उष्णीभवन्ति । काष्ठखण्डद्वयघर्षणमग्न्युत्पत्त्यर्थं कदाचित् मनुष्याः प्रकुर्वन्ति ॥

। २ । उष्णतावत् प्रकाशो ऽपि गुरुत्वरहितो ऽस्ति । तं विना दृष्टिर्न भवति । अथ दर्शनानुशासनम् ॥

। ३ । इह दर्शनानुशासने स्वप्रकाशपरप्रकाशपारदर्शकभेदात् पदार्थास्त्रिविधा ज्ञेयाः । सूर्यदीपादयः स्वप्रकाशाः । लोहादयः परप्रकाशाः । काचादयः पारदर्शकाः । अत्र प्रसङ्गे पारदर्शका मध्यस्थसंज्ञाः स्युः ॥

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स्वप्रकाशपदार्थात्प्रकाशकिरणा निर्गत्य सर्वतः सरलरेखाभिर्व्रजन्ति ॥ ४७ ॥

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। १ । तत्र मार्गे यदि परप्रकाशः पदार्थः स्यात्तदा तेन प्रकाशावरोधात् तत्पृष्ठे तमो भवति । तत्र यदि भित्त्यादि स्यात्तर्हि छाया उत्पद्यते ॥

। २ । प्रायश्छाया अत्यन्तकृष्णा न भवति यतो यत्र छाया जायते तत्र प्रायोऽन्यपदार्थपरावृत्तः प्रकाश आगच्छति यथा दीपद्वयेन घटस्य छायाद्वयमुत्पद्यते तत्रैकस्मिन्दीपे नष्टे एकैव छाया कृष्णतरा भवति किन्तु न सा अत्यन्तकृष्णा यतो गृहभित्त्यादिसमीपपदार्थपरावृत्तः प्रकाशस्तत्र गच्छति ॥

। ३ । अथ यत्र स्वप्रकाशः पदार्थः परप्रकाशात्पृथुतरो वर्तते तत्र किरणमार्गस्य सरलत्वात् छाया क्रमेण न्यूनीभूयान्ते विनश्यति । एवं यदा कदाचित् सूर्यग्रहणे चन्द्रच्छाया भुवं

नागच्छति तदा क्वचित् चन्द्रं परितो वलयाकारो रविर्दृश्यते ॥

। ४ । यत्र स्वप्रकाशः परप्रकाशादल्पीभवति तत्र छाया-दूरत्वानुसारेणोत्तरोत्तरं वर्द्धते यथा दीपकृता मनुष्यच्छाया कदाचिद्विंशतिहस्तपरिमाणा स्यात् ॥

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प्रकाशो ऽतिशीघ्रं गच्छति ॥ ४८ ॥

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। १ । सूर्य्यान्निर्गतः किरणो दण्डतृतीयांशकालेन भुवमेति । अतो यदा किरणो भुवमागच्छति ततः पूर्वमेव दण्डतृतीयांशकालेन रविः किरणनिर्गमकालिकं स्वस्थानं त्यजति । अथ प्राप्तकिरणदिश्येव दण्डतृतीयांशेनातिक्रान्ते स्थाने वयं रविं पश्यामः ॥

। २ । अथ प्रकाशकिरणगतिमितिः पूर्वं कथमवगतेति तदुच्यते । गुरोश्चत्वारश्चन्द्राः सन्तीति पूर्वमुक्तम् तेषाञ्च ग्रहणानि मुहुर्भवन्ति । तत्काला रविग्रहणवद्गणितेन ज्ञातुं शक्याः । अथ यदा रविगुर्वोर्मध्ये भूर्वर्तते तदा गुरुः भूनिकटे तिष्ठति यदा च कुगुर्वोर्मध्ये रविरास्ते तदा गुरुःभूमेर्दूरे तिष्ठति । अथ गुरुसमीपवर्तनकाले सञ्जातानां ग्रहणानां दृग्गणितैक्यङ्कृत्वा तदनुसारतोऽन्यानि आगामिकालिकग्रहणानि ज्योतिर्विदो गणितेन निरणयन् । परन्तु तानि ग्रहणानि गुरुदूरवर्तनकाले दण्डतृतीयांशद्वयविलम्बेनापश्यन् । ततो दूरत्वात्किरणागमेयं विलम्बो-

ऽभूदित्यनुमाय किरणगमनमानं गणितेनावागच्छन् । तद्यथा । भूमिसूर्ययोरन्तरं पञ्चचत्वारिंशन्नियुतक्रोशमितमस्तीति प्रसिद्धम् । अतो भूगुर्वोर्गुरुनिकटवर्तनकालभवादन्तराच्चद्दूरवर्तनकालिकमन्तरं नवतिनियुतक्रोशैरधिकं स्यादिति स्पष्टम् । अत एव प्रकाशकिरणो दण्डतृतीयांशद्वयेन नवतिनियुतक्रोशान् गच्छति । एकेनासुपादेनच लक्षक्रोशासन्नङ्गच्छतीति स्पष्टम् ॥

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यदा प्रकाशकिरणाः परप्रकाशे पतन्ति तदा ते
प्रायः परावजन्ति भित्तौ प्रक्षिप्ताः स्थितिस्थापक-
विशिष्टा गोला इव ॥ ४९ ॥

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। १ । अत्रापि पतनपरावर्तनकोणयोः साम्यम्भवति । अन्धकारमये गृहे यदि अतिसूक्ष्मच्छिद्रेणागतः सूर्यकिरणो दर्पणोदरे लम्बरूपः पतेत्तदा एक एव किरणो लक्ष्यते पतनपरावर्तनरेखयोरैक्यात् । पुनर्यदि दर्पणस्तिर्यक् क्रियते तदा तथा न भवेत् ॥

। २ । स्वप्रकाशपदार्थादागतैः किरणैः स पदार्थो दृश्यो भवति । अन्ये तु परावृत्तकिरणैरेव दृश्या भवन्ति । दर्पणे किरणः पततीति पूर्वमुक्तं । तत्र स किरणो ऽस्माभिर्न दृश्यते किन्तु छिद्रदर्पणयोर्मध्यावकाशे रजोबाहुल्यं वर्तते । अतस्तद्रजसः परावृत्तः प्रकाशोऽस्माकं नेत्रयोर्लगति ॥

यदा प्रकाशकिरणः कस्मिंश्चित्पारदर्शकं त्यक्त्वा अन्यस्यापि पारदर्शकस्य मार्गेण गच्छेत् तदा किरणवक्रीभवनं जायेत ॥ ५० ॥

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। १ । अत एव यदा दण्ड ऊर्ध्वाधररूपो जले वर्तते तदा तस्य निमग्नोंऽशोऽल्पीभूतो दृश्यते । यदा तिर्यक् वर्तते तदा स जलपृष्ठस्थाने भग्नो दृश्यते । इदङ्किरणवक्रीभवनसंज्ञं स्यात् । एवं प्रकाशः कस्यापि पारदर्शकस्य मार्गेण गच्छेत् तदापि किरणवक्रीभवनं जायेत ॥

। २ । प्रकाशकिरणो वायुं त्यक्त्वा जलं विशतीति कल्प्यतां । तदा यदि स किरणो जलपृष्ठे लम्बरूपः पतेत् तदा वक्रो न भवति किन्तु यदि लम्बरूपो न स्यात्तदा स वक्रीभूय लम्बदिशि गच्छति ॥

। ३ । पुनर्यदा किरणो घनविषयात् सूक्ष्मविषये गच्छति तदा पूर्वोक्तरीतिविपर्ययेण स लम्बाद्दूरे वक्रीभूय गच्छति ॥

। ४ । एतत्प्रतीत्यर्थं मृत्पात्रे मुद्रां संस्थाप्य तत्पात्रन्ताद्दृशे स्थाने न्यसेत् यत्र सूर्यदीपादिकिरणैर्मुद्रासन्नाः पात्रांशाः प्रकाश्यन्ते किन्तु मुद्रा अप्रकाशित स्यात् । ततस्तस्मिन्पात्रे मन्दं मन्दंजलं क्षिप्यतां । तदा ते किरणा लम्बदिशि वक्रीभूय तां मुद्राम्प्रकाशयेयुः ॥

। ५ । अपिच पात्रे मद्रां विन्यस्य तामवलोकयन् पश्चात्ता-

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वदपसरेद्यावत् सा मुद्रा पात्रपार्श्वेण तिरोहिता स्यात्तदा यदि कश्चन तत्पात्रे मन्दं मन्दं जलम्प्रक्षिपेत् तदा सा मुद्रा दृष्टा भवेत् । यतो ये किरणा मुद्रापरावृत्ताः पूर्वं पात्रकण्ठमागम्य नेत्रस्योपरिभागे जग्मुस्तेऽधुना लम्बात् दूरतः नेत्रे पतन्ति ॥

। ६ । अत एव सरित्सरस्यादीनां यत्तलं लक्ष्यते तद्वास्तवतलादुच्छ्रिततरम्भवति । तेन तरणविद्यायामकुशला अज्ञानिनो बाला अत्र जलं गम्भीरं नास्तीति विचिन्त्य तत्र स्नानार्थङ्गत्वा विनश्यन्ति ॥

। ७ । सूर्यतारादीनाङ्किरणाः साधारणवायावागम्याधो वक्रीभवन्ति । तेन क्षितिजसमीपे यदा ग्रहादि खस्थं वर्तते तदा तद्वास्तवस्थानादुच्चदेशे दृश्यते । नेत्रकिरणसंयोगकाले यस्या दिशो द्रव्यपरावृत्तः स किरण आयाति तस्यामेव दिशि तद्द्रव्यं वर्तत इति नेत्रेण बुध्यते ॥

। ८ । यत्खस्थमूर्ध्वस्वस्तिके वर्तते तस्य किरणा वक्रा न भवन्ति । क्षितिजस्थस्य वक्रीभवनम्परमं विद्यते । तत उन्नतस्य किरणवक्रीभवनन्यूनता स्यात् । अतः सूर्योदयसमये बिम्बोर्ध्वभागकिरणवक्रीभवनमपेक्ष्याधोभागकिरणवक्रीभवनमधिकम्भवति । अत एव यदा आर्द्रतादिहेतुभि र्वायुर्घनोऽस्ति दयकाले रविबिम्बमण्डवत् दृश्यते ॥

। ९ । अथ ज्यौतिषगणितविषये किरणवक्रीभवनभूतं शू-

र्यादिस्थानान्तरमवश्यमनुमेयं भवति । अतः कुजादूर्ध्वं प्रत्यंशं वक्रीभवनफलं निश्चित्य ज्यौतिषसारण्यां लिखन्ति ॥

। १० । काचमयसमानशिलायां यः किरणो लम्बरूपो न पतति स पूर्वं काचप्रवेशकाल उक्तवल्लम्बदिशि वक्रीभूय ततो निर्गमकाले पुनर्लम्बाद्दूरे गच्छतीति । इह तद्वक्रीभवनं द्विविधम्भवति । अतः किरणगतौ स्वल्पो विकारो भवति ॥

। ११ । अथ गोलखण्डरूपे मध्योन्नतकाचे ये किरणाः पतन्ति तत्र तद्गोलकेन्द्रगामी किरणो वक्रत्वन्नाप्नोति । अन्येच प्रवेशकाले तदच्चदिशि वक्रीभवन्ति निर्गमकालेच प्रोक्तकारणानुसारतः सर्वेऽग्र एकस्मिन् बिन्दौ समुद्यन्ति ॥

। १२ । सूर्यकिरणानां तत्समुदयस्थले पटादिद्रव्याणि ज्वलन्ति ॥

। १३ । अथ मध्योन्नतकाचद्वारा सूक्ष्मः पदार्थो महान्दृश्यते ॥

। १४ । अथ तद्धेतुभूतमुच्यते । नेत्राद्दूरे यः पदार्थो वर्तते सोऽल्पो दृश्यते यश्च निकटे स महान् दृश्यत इति प्रसिद्धम् । अथ नेत्राद्धस्ततृतीयांशमितदूरदेशे स्थितः पदार्थः स्वस्थनेत्रेणातिस्पष्टो दृश्यते । तदधिकसमीपे स्थितस्ततो महानप्यस्पष्टो दृश्यते तत्तद्दूरे धृतं पुस्तकमालोक्य एतत्प्रतीतिरुत्पाद्या ॥

। १५ । अथास्पष्टत्वे हेतुरुच्यते । नेत्राग्रभागे स्वच्छजलनि-

र्मितो मध्योन्नतकाचवत् नेत्रांशो वर्तते । तत्र स्वस्थे नेत्रे कि-रणवक्रत्वं तादृशम्भवति येन हस्ततृतीयांशान्तरितप्रदेशादा-गताः किरणाः नेत्रान्तःस्थितचित्रपत्रे पूर्वोक्तरीत्या एकत्र स-मुच्चन्ति तेन दृष्टिस्पष्टता जायते ॥

। १६ । वृद्धमनुष्यस्य नेत्रे प्रायस्तदंशजलं न्यूनम्भवति तदा तत्कृतकिरणवक्रीभवनमपि न्यूनञ्जायते । अतो हस्ततृतीयां-शान्तरितदेशे स्थितस्य ग्रन्थस्य वर्णाः वृद्धमनुजेन स्पष्टं नेच्यंते हस्तमितदूरात्स्फुटतरमवलोक्यन्ते ॥

। १७ । तद्धस्ततृतीयांशदूरात् स्फुटमालोकयितुं काचद्व-यनिर्मितमधिककिरणवक्रत्वकारकमुपनेत्रसंज्ञकं यन्त्रं क्रियते ॥

। १८ । अथात्यन्तकिरणवक्रत्वकारकमध्योन्नतकाचद्वारा नेत्रस्यातिनिकटेऽपि स्थितः सूक्ष्मः पदार्थः स्फुटमतिमहान् दृश्यते । अतस्तादृशः काचखण्डः सूक्ष्मदर्शक इत्युच्यते ॥

। १९ । अथ सूक्ष्मदर्शकनिर्माणस्य सुगमोपायोऽयम् । अ-स्थूले ताम्रादिपत्रे सूक्ष्मं वृत्तच्छिद्रं क्रियताम् । तत्र स्थितो ज-लबिन्दुर्गोलीभूय सूक्ष्मदर्शको भवति ॥

। २० । यदि कस्यचिद्गाढान्धकारस्य गृहस्याभ्यन्तरे तिष्ठन् पुमांस्तस्यैकस्मिन् कपाटे सूक्ष्मं छिद्रं कृत्वा तस्याग्रतः शुक्लं व-स्त्रखण्डं निदध्यात् तर्हि तस्मिन् वस्त्रे तद्गृहबहिःस्थानां मनुष्य-गृहवृक्षादीनां प्रतिबिम्बं प्रादुर्भवेत् । यदि तु तस्मिंश्छिद्रे-मध्योन्नतः काचो घटितः स्यात् तर्हि बाह्यवस्तुप्रतिबिम्बान्य-

त्यन्तस्पष्टानि भवेयुः । एतत्तुल्य एव प्रकारश्चक्षुष्यपि वर्त्तते ॥

। २१ । मध्यनिम्नकाचखण्डस्य धर्माः पूर्वोक्तविरुद्धा ज्ञेयाः । तद्द्वारा पदार्था अल्पतरा दृश्यन्ते ॥

। २२ । कदाचित् कस्यचिद्बालकस्य चक्षुषि पूर्वोक्तस्वच्छजलनिर्मितांशस्य जलाधिक्येन किरणवक्रत्वं तादृशम्भवति येन हस्ततृतीयांशमितदूरादागतानां किरणानां समागमो नेत्रस्य मध्ये भवति। तत्र किरणा एकीभूयाग्रे स्वस्वरेखायाङ्गत्वा पृथक् चित्रपत्रे पतन्ति। अतस्तत्र दृष्टिस्पष्टत्वं न भवति। स बालकोऽतिसमीपस्थान एव पदार्थान्स्पष्टम्पश्यति । पठनकाले नासिकाग्रभागेषु स्तकन्दधाति ॥

। २३ । अथ तस्य हस्ततृतीयांशदूरात्स्पष्टतया आलोकनार्थं मध्यनिम्नकाचद्वयेन तादृशं यन्त्रं क्रियते यद्द्वारा विरुद्धवक्रत्वमापन्नाः किरणाः तस्य नेत्रे गच्छेयुः ॥

। २४ । तस्य बालकस्य वृद्धत्वे यदि नेत्रवर्तिजलस्य न्यूनता स्यात् तदा स जातु यन्त्रं विनैव स्पष्टन्द्रक्ष्यति इति तस्य लाभः ॥

२५ । ये पदार्था वस्तुतः सूक्ष्मा न सन्ति किन्तु दूरत्वहेतोः सूक्ष्मा दृश्यन्ते तेषां स्पष्टत्वेन दिदृक्षा चेत् तर्हि तत्र दूरदर्शकयन्त्रम्प्रयोजयेत् ॥

। २६ । एतद्यन्त्रस्यानेके प्रकारा भवन्ति । तत्रैको वर्ण्यते । तथाहि । उपयुक्तनलिकाया अन्ते तादृशो विपुलदर्शकः काचखण्डः स्थाप्यते येन दूरस्थितपदार्थादागताः किरणाः वक्रीभवेयुः । अपिच किरणानामेकीभवनस्थानात्पूर्वं नलिका-

या अपरान्ते स्थापितेन मध्यनिम्नकाचखण्डेन तद्वक्रत्वस्य ताद्दश: प्रतिरोध: क्रियते येन दृष्टिस्पष्टत्वं भवेत्। तथाच तेन स पदार्थो महाकारो दृश्यत आसन्न इव बुध्यतेच ॥

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शुक्ल: किरणो विचित्ररूपकिरणनिर्मितोऽस्ति ॥ ५१ ॥

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। १ । अस्य प्रमाणमुच्यते। काचमयं गोलरूपञ्जलपूर्णम्पात्रं स्वशिरोऽपेच्योच्चतरे स्थाने विन्यस्य सूर्यपात्रयोर्मध्ये तिष्ठेच्चेतर्हि ये ये विचित्रा वर्णा इन्द्रधनुषि दृश्यन्ते तान् सर्वान् तत्पात्रे पश्यति । तथाहि पात्र उत्थापित ऽध:कृते वा क्रमेण पीतहरितनीलादिरूपाणि दृश्यन्ते। अथ स्वच्छजलादेतद्रूपवैचित्र्यं कथमुत्पद्यत इत्येतदर्थमुच्यते शुक्ल: किरणस्तद्विचित्ररूपकिरणनिर्मितोऽस्तीति ॥

। २ । परप्रकाशपदार्था: परावृत्तै: किरणैरेव दृश्यन्त इति पूर्वमुक्तम्। परं नहि सकलपदार्थेभ्य: सकलकिरणा: परावृजन्ति। यस्मात् सर्वे परावृजन्ति स एव शुक्लो दृश्यते। यस्मात्कोऽपि किरणो न परावृजति स कृष्णो दृश्यते ॥

। ३ । तेजसा सह तत्रत्योष्णतापि परावृजति प्रविशति वा। अत: कृष्णवस्त्रमुष्णम्भवति शुक्लञ्च शीतम्। अपिच विपुलदर्शककाचखण्डकृष्णं वस्त्रं शीघ्रं दहति न तथा शुक्लम ॥

। ४ । यस्मात्पदार्थाद्रक्तकिरणा एव परावृजन्ति स रक्तो

दृश्यते यस्माच्च पीतकिरणाः स पीत इत्यादिरूपधर्मो बोध्यः ॥

। ५ । अथ शुक्लकिरणवर्तिरक्तपीतनीलरूपाणां वक्रीभवनशीलं समानं न भवति । पीतमपेक्ष्य नीलस्य वक्रत्वमधिकम्बोध्यं रक्तस्य च न्यूनम् ॥

। ६ । एतत्प्रतीत्यर्थञ्चतुर्भुजाकृतिपार्श्वत्रयविशिष्टङ्काचखण्डमन्धकारमये गृहे तथा स्थाप्यं यथा तत्र सूक्ष्मच्छिद्रेणान्तः सूर्यकिरणः पतेत् तदा तच्छिद्रागतो यः किरणः पूर्वस्मिन्त्तौ शुक्ल एव दृष्टः स रक्तपीतनीलादिरूपयुक्तो दृश्यते । त्रिपार्श्वकाचखण्डकृता किरणवक्रगतिः पूर्वोक्तवक्रीभवनधर्मानुसारेण विपुलदर्शककृतेव वारद्वयं समानदिशि विद्यते परन्तु पार्श्वसमत्वात् न तथा किरणसमाहारो जायते ॥

। ७ । यदि त्रिपार्श्वकाचेन भिन्ना विचित्ररूपकिरणा विपुलदर्शककाचे पतन्ति तदा पूर्वोक्तवक्रीभवनधर्मानुसारेण पुनस्ते एकीभूय शुक्लं स्वरूपम्प्रकटयन्ति । एवम्प्रकारेण किरणस्य पृथक्करणं पुनरेकीकरणञ्च कर्तुं शक्यते ॥

। ८ । कुज्झटिकासमये रवेरागता रक्तरश्मयो नेत्रमागच्छन्ति । अन्येतु अधिकवक्रीभूतत्वात् नायान्तीति तत्काले रवी रक्तरूपो दृश्यते ॥

। ९ । अथ यथा त्रिपार्श्वकाचेन जलपूर्णकाचपात्रेण वा शुक्लकिरणस्य विचित्ररूपाणि पृथक् भवन्ति तद्वद्वर्षणकाले भानुभानवः पतद्बिन्दुसन्दोहे पतित्वा पृथग्भूताश्च नेत्रमायान्ति

रक्तपीतनीलादिप्रत्यक्षं सूर्यनेत्रबिन्दुजातकोणपरिमाणाश्रितमिति पूर्वोक्तजलपूर्णकाचपात्रस्य परीक्षणेन सिद्धम् ॥

। १० । अथ ये जलबिन्दवो रविनेत्राभ्यान्तुल्यकोणेषु वर्तन्ते ते वृत्तवृतिवर्तिन एव भवन्ति इति चेत्रगणितज्ञेन ज्ञायते । अत इन्द्रचापाकारो वृत्त एवभवतीति ॥

। ११ । घर्षणेनोष्णतायास्तेजसश्च प्रादुर्भावो भवतीत्युक्तं तथा गुरुत्वरहितोऽन्योऽपि कश्चित्पदार्थो घर्षणेन प्रादुर्भवति स च विद्युदित्युच्यते ॥

। १२ । अथ लोके विद्युच्छब्दस्य मेघसम्बन्धिनि तेजोविशेष एव प्रसिद्धतया प्रकृते तादृशतेजोविशेषादन्यस्याप्यर्थस्य विद्युच्छब्दव्यवहार्यतासूचनार्थं प्रसिद्धविद्युतः स्वाभिप्रेतविद्युच्छब्दार्थस्यचाविशेषमाह ॥

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घर्षणप्रयोज्या तृणमणिशक्तिः प्रसिद्धविद्युतो न विशिष्यते ॥ ५२ ॥

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। १ । तथाह्यूर्णावस्त्रघर्षिते तृणमणौ न केवलमुष्णताऽपि त्वन्येऽपि शक्तिविशेषाः प्रादुर्भवन्ति यतो घर्षितस्तृणमणिर्लघुतराणां तृणशकलादीनामाकर्षणादिकं करोति । एवं यदि कश्चित् पुमान् सुमहान्तं तृणमणिखण्डमादायोर्णावस्त्रेण घर्षयित्वा तत्समीपे स्वांगुलिं नयेत् तर्हि ततो निर्गच्छतीं चटचटा-

शब्दयुक्तानां स्फुलिङ्गानामाघातेनांगुल्यवच्छेदेन स्वल्पां पीडा-
मनुभवेत् । त एते तृणमणौ दृश्यमानाः पीडाजनकाः शब्दयु-
क्ताः स्फुलिङ्गा मरणजनकाद् घनगर्जितयुक्ताद् विद्युन्नाम्ना प्रसि-
द्धात् तेजोविशेषादल्पत्वमहत्त्वयोरन्यस्मिन् विषये नातिरिच्यन्ते
यथैको जलबिन्दुर्महाजलसङ्घातात् । तथाच तृणमणिगतवर्ष-
णप्रयोज्योक्तविधशक्तिजातीयाः सर्वा अपि शक्तयः प्रसिद्धविद्युतो
विशेषाभावाद् विद्युच्छब्देन व्यवहर्तव्याः ॥

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एवंविधा विद्युत् साम्यदशायां तिरोभवति वैषम्य-
दशायां तु कार्याणि जनयति ॥ ५३ ॥

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। १ । वैषम्यविशिष्टाया विद्युतः कार्याण्याह ॥

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प्रकाशः शब्द आकर्षणमुत्सारणं धातुद्वारा गमनं
शीघ्रगमनं येषां पारे याति तेषां विदारणमाह-
न्यमनाप्राणिमरणकम्पने दाह्यपदार्थदाहो धातू-
नां द्रवीकरणमित्यादीनि वैषम्यविशिष्टविद्युत्का-
र्याणि ॥ ५४ ॥

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। १ । इहोक्तानां प्रकाशादीनां विद्युत्कार्याणां सम्पादन
उपयुक्ताः कतिचन परीक्षाविशेषाः सन्ति । ते यथा । महान्तं
लाक्षादण्डं सुशुष्कीकृतेनोर्णावस्त्रेण दृढं घर्षयित्वा तत्समीपे

स्वांगुलिं नयेत् तथाकृते तत्र सप्रकाशाः स्फुलिङ्गाः सह चटचटाशब्देन दृश्यन्ते तेन तस्मिन् दण्डे विद्युद्वैषम्यमनुमीयते ॥

। २ । तदिदं विद्युद्वैषम्यं प्रायेण सर्वेषु भौतिकद्रव्येषु यथोचितघर्षणेनोत्पादयितुं शक्यते । तत्र कानिचिल्लोहताम्रादीनि द्रव्याणि कष्टसाध्यविद्युद्वैषम्याणि । कानिचिच्च काचादीनि सुखसाध्यविद्युद्वैषम्याणि । काचनलिका हि हस्तद्वयदीर्घा ऽङ्गुलद्वयविशाला सुशुष्कीकृता कौशेयवस्त्रेण दृढं घर्षिता सती लाक्षादण्डवदेव स्फुलिङ्गान् किरति ॥

। ३ । अथ लाक्षादण्डनिष्ठस्य काचनलिकानिष्ठस्य च विद्युद्वैषम्यस्य च न समत्वमित्याह ॥

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घर्षितयोर्लाक्षादण्डकाचनलिकयोर्विद्युद्वैषम्यं
परस्परविधर्मकं भवति ॥ ५५ ॥

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। १ । अत्र परस्परविधर्मकत्वं परस्परविधर्मककार्यकारित्वं । तथाहि घर्षितकाचनलिकाया नातिदूरे विधृतस्य मृदुलोमवतः पक्षस्य लोमानि प्रथमं तन्नलिकाभिमुखं गन्तुमारभन्ते स पक्षोऽपि हस्तान्मुक्तस्तया नलिकया शीघ्रमेवसम्बध्यते अथ कतिपयक्षणोत्तरं तानि लोमानि परस्परं वियुज्यमानानि दृश्यन्ते ततो नलिकास्थाया विद्युतः स्वस्मिन् प्रवेशात् स पक्षोऽपि सत्वरं नलिकातो दूरमपसरति । अथ स यावत् स्वगतां विद्युतं समीपव-

तिनो विद्युद्द्वारभूतस्य हस्तादेर्योगेन न जहाति तावदेव यदि सा नलिका तस्य पक्षस्य समीपमानीयते तदा स दूरं दूरमपसरति । अनेन प्रकारेणैष पक्षो निराधार एव तद्गृहे यत्र कुत्रापि देशे सञ्चारयितुं शक्यते । अथोक्तरीत्या काचनलिकातः परावृत्तस्य पक्षस्य समीपे यदि दृढघर्षितो लाक्षादण्डो नीयते तर्हि स लाक्षादण्डेनाकृष्यते । एवं घर्षितलाक्षादण्डेनादौ सम्बध्य ततः परावृत्तः पक्षो घर्षितकाचनलिकयाकृष्यत इति एवं लाक्षादण्डकाचनलिकयोरेकेनोत्सारितं पदार्थमपर आकर्षतीत्येवं परस्परविधर्मकमाकर्षणोत्सारणाख्यं कार्यद्वयं लाक्षादण्डकाचनलिकागतविद्युद्वैषम्याभ्यां जायत इति ॥

। २ । ननु विद्युद्वैषम्यरूपस्य हेतोः स्वरूपे यदि नोभयत्र वैलक्षण्यं तर्हि कथं युगपदेव विलक्षणकार्योत्पत्तिः कारणवैलक्षण्यमन्तरेण कार्यवैलक्षण्यासम्भवादिति चेत् । अत्र केचित् । लाक्षादण्डे काचनलिकायां चाकर्षणोत्सारणरूपविरुद्धकार्ययोर्युगपन्निर्वाहकं परस्परविलक्षणं विद्युद्द्वयमस्तीत्याहुः । परे तु सर्वपदार्थेषूष्णतेवावैषम्येन स्थितिमिच्छन्तो विद्युत् प्रतिपदार्थमविलक्षणैकैवास्ति । तस्याः साम्यावस्थायां न किमपि कार्यमाविर्भवति केनचित् तु कारणेन तस्या वैषम्ये समुत्पन्ने पुनस्तत्साम्यसिद्ध्यनुकूलानि प्रकाशादीनि पूर्वोक्तानि कार्याणि जायन्त इत्याहुः । युज्यते चोत्तर एव कल्पो लाघवात् । अथैतावताऽपि प्रकृते किमायातमिति चेत् शृणु । घर्षणहेतोः स्वगतवि-

युद्भागं परित्यजता कौशेयवस्त्रेण काचनलिकायामुपचयप्रयुक्तं विद्युद्वैषम्यमुत्पाद्यते । घर्षणहेतोर्लाक्षादण्डगतविद्युद्भागमाकर्षतोर्णावस्त्रेण तु लाक्षादण्डे ऽपचयप्रयुक्तं विद्युद्वैषम्यमुत्पाद्यते । तथाच तदुभयगतस्य विद्युद्वैषम्यस्य वैजात्यात् कार्यवैषम्यमुपपद्यते । आकर्षणे चोत्सारणे चोभयत्रापि फलं विद्युत्साम्यसिद्धिरेवेति ॥

। ३ । अथ विद्युद्वैषम्येण स्थितिमिच्छतीति यदुक्तं तदुपपादनाय तन्निर्वाह्यकार्याण्याह ॥

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समानजातीयविद्युद्वैषम्याश्रयौ पदार्थावन्योन्यमुत्सारयतो भिन्नजातीयविद्युद्वैषम्याश्रयौ त्वाकर्षतः ॥ ५६ ॥

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। १ । समानेत्यादि । तथाहि यदोपचयप्रयुक्तविद्युद्वैषम्यवत्याः काचनलिकायाः संयोगेन पक्षेऽपि तज्जातीयमेव विद्युद्वैषम्यं जायते तदा तया सोऽपसार्यते अपचयप्रयुक्तविद्युद्वैषम्यवता लाक्षादण्डेन तु स भिन्नजातीयविद्युद्वैषम्यवत्त्वादाकृष्यते पक्षगतो विद्युद्भागश्चादीयते । यदि च कश्चिद् विद्युद्वैषम्यवतीं काचनलिकामेकेनापरेण च हस्तेन तथाविधमेव लाक्षादण्डं धृत्वा तयोर्मध्ये कौशेयसूत्रेण पक्षमान्दोलयेत् तर्हि स पक्षः काचनलिकालाक्षादण्डाभ्यां पर्यायेणाकृष्ट उत्सारितश्च भवेद्यावत् तस्मिंस्तितयेऽपि पूर्ववद् विद्युतः साम्यं न जायेत ॥

। २ । अथेमावुपचयापचयरूपौ विद्युतो धर्मौ परस्परा-
श्रिताविन्याह ॥

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कस्मिंश्चिद् द्रव्ये तत्प्रमाणमुपचयप्रयुक्तं विद्युद्वै-
षम्यं तत्काले तत्प्रमाणस्यापचयप्रयुक्तस्य विद्युद्वैष-
म्यस्योत्पत्तिमन्तरा नोत्पादयितुं शक्यते । न वा
तत्प्रमाणमपचयप्रयुक्तं विद्युद्वैषम्यं तत्काले तत्प्र-
माणस्योपचयप्रयुक्तस्य विद्युद्वैषम्यस्योत्पत्तिमन्त-
रोत्पादयितुं शक्यते ॥ ५७ ॥

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। १ । तत्प्रमाणेत्यादि । तथाहि यदि काचनलिका कौशे-
येन घृष्यते तदा तस्यां येन प्रमाणेनोपचयप्रयुक्तं विद्युद्वैषम्यमु-
त्पद्यते तेनैव प्रमाणेनापचयप्रयुक्तं विद्युद्वैषम्यं कौशेयवस्त्रधारके
हस्त उत्पद्यते ॥

। २ । अथ यदि हस्तेऽपि लाचादण्डादिवदपचयप्रयुक्तं
विद्युद्वैषम्यमुत्पद्यते तर्हि हेतुसाम्याद्धस्तेऽपि वैषम्यविशिष्टाया
विद्युतः कार्याणि भवेयुर्नच दृश्यन्त इत्याशङ्कां निराकर्तुमाह ॥

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द्रव्याणि द्वेधा भवन्ति कानिचिद् धात्वादीनि वि-
द्युद्वैषम्याश्रयाद् द्रव्याद् विद्युतोऽपगममार्गभूतानि
सन्ति कानिचित् तु न तथाऽपितु तदपगमप्रति-
बन्धकानीव ॥ ५८ ॥

। १ । द्रव्याणि द्वेधेत्यादि । अयं भावः । यद्युपचयप्रयुक्त-विद्युद्वैषम्यवद् द्रव्यं हस्तेधृतेन धातुखण्डेन स्पृश्यते तर्हि तद्द्रव्यगता ऽधिका विद्युद् भूमिं प्रविशति धातोर्मनुष्यशरीरस्य च विद्युदपगममार्गभूतत्वात् । यदि पुनस्तादृशं द्रव्यं हस्ते धृतेन काचखण्डेन स्पृश्यते तर्हि विद्युत् तस्मिन्नेव द्रव्ये तिष्ठति काचस्य विद्युदपगमप्रतिबन्धकत्वात् । अतश्च भूस्थस्य मनुष्यस्य काचनलिकाघर्षणेनापचयप्रयुक्तविद्युद्वैषम्याश्रये सकौशेये हस्ते विद्युत्कार्याणि न प्रादुर्भवन्तीत्येतदुपपद्यते । मनुष्यशरीरस्य विद्युदपगममार्गभूततया हस्तगतविद्युतो भूमिगतविद्युतश्च वैषम्योत्पत्त्यव्यवहितोत्तरक्षणएव तदुभयस्य साम्यसिद्धेः । अतो यदि कश्चित् पुमान् काचफलकमधिष्ठाय काचनलिकायाः कौशेयेन घर्षणं कुर्यात् अन्यश्च कश्चित् तत्समीपे स्वाङ्गुलिं नयेत् तर्हि तयोर्मध्ये स्फुलिङ्गदर्शनं भवेत् तेनचेदमनुमीयते यत् काचनलिकाघर्षणकर्तुः शरीरे विद्युद्वैषम्यं जातमिति ॥

। २ । अथ द्रव्याणां विद्युदपगममार्गभूतत्वाभावस्य लिङ्गमाह ॥

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यत्र यत्र सुखसाध्यविद्युद्वैषम्यत्वं तत्र तत्र विद्युद-पगममार्गभूतत्वाभावः ॥ ५९ ॥

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। १ । यत्र यत्रेत्यादि । काचे लाक्षायां च घर्षणेन विद्युद्वैषम्यं सुखसाध्यमिति हेतोर्विद्युत् कस्माच्चिद् विद्युद्वैषम्याश्र-

यात् पदार्थान्निर्गत्य काचलाक्षोभयद्वारा ऽन्यपदार्थं प्रति न याति । अपिच तदुभयं विद्युत्प्रतिरोधकत्वेनोपयुज्यते व्यवह्रियते च । यतः काचमये लाक्षामये वा स्थले निहिते द्रव्ये वर्तमाना विद्युत् कारागार इव रुद्धा तिष्ठति ॥

। २ । तत्र धातवो जलं सजीवं स्थावरजङ्गमं विरलीकृतो वायुश्चेत्यादयो विद्युदपगममार्गभूताः । लाक्षादरुडस्तृणमणिर्गन्धकः सिक्थकं काचः कौशेयं केशाः पक्षाः शुष्कं लिपिपत्रं शुष्को वायुरत्यन्तशुष्कीकृतं काष्ठमित्यादयो न विद्युदपगममार्गभूताः ॥

। ३ । अथ विद्युद्वैषम्यं द्रव्य जायमानं किं सर्वावयवावच्छेदेन जायते ऽथवा यत्किञ्चिदवयवावच्छेदेनेत्याशङ्कां निवारयितुमाह ॥

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द्रव्येषु विद्युद्वैषम्यं पृष्ठावच्छेदेनैव न तु गर्भेऽपि ॥ ६० ॥

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। १ । पृष्ठेत्यादि । यतो निरवकाशगर्भे धातुपिण्डे सावकाशगर्भाद् धातुपिण्डादधिका विद्युन्न तिष्ठति । एतद्विषयोपपत्तिविस्तरो ग्रन्थान्तरे द्रष्टव्यः ॥

। २ । एवं तावदेकव्यक्तिनिष्ठस्य विद्युद्वैषम्यस्यान्यव्यक्तौ विद्युन्मार्गभूतपदार्थसम्बन्धद्वारा विद्युद्वैषम्योत्पादकत्वाद् विद्युतः प्राप्यकारित्वं निरूपितम् । अथ विद्युन्मार्गभूतपदार्थसम्बन्ध-

रहितेष्वपि दूरवर्तिषु पदार्थेष्वन्यपदार्थगतविद्युद्वैषम्यवशाद् विद्युद्वैषम्योत्पत्तेर्दर्शनाद् विद्युतोऽप्राप्यकारित्वमप्यस्तीत्याह ॥

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यदा वैषम्यविशिष्टविद्युदाश्रयभूतः पदार्थो विद्युत्साम्यविशिष्टानां पदार्थानां समीपं नीयते तदा तेषु स्वगतविद्युद्वैषम्यविजातीयं विद्युद्वैषम्यं जनयति ॥ ६१ ॥

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। १ । तथाह्युपचयप्रयुक्तविद्युद्वैषम्याश्रयः पदार्थो विद्युन्मार्गभूतपदार्थद्वारकस्वसम्बन्धरहितेषु द्रव्येषु स्वसन्निहितावयवावच्छेदेनापचयप्रयुक्तविद्युद्वैषम्यं करोति । तदिदं करणं पूर्वोक्तप्राप्यकरणविलक्षणत्वादप्राप्यकरणमित्युच्यते । तत्र विद्युदपगमप्रतिबन्धकपदार्थद्वारा विद्युतः प्राप्यकरणाभावेऽपि तद्द्वारा ऽप्राप्यकरणं सम्भवत्येव । यथा । आदौ तावच्चतुष्कोणस्य काचफलकस्य पार्श्वद्वये ततो ऽल्पपरिमाणे चतुष्कोणे लोहपट्टिके योज्ये ततो वैषम्यविशिष्टविद्युदाश्रयभतकाचनलिकया तयोः पट्टिकयोरेका स्प्रष्टव्या । तथासत्युपचयप्रयुक्तविद्युद्वैषम्याश्रयीभूता सा पट्टिका मध्यवर्तिकाचद्वारेणाप्राप्यकरणाख्यशक्तिवशात् पट्टिकान्तरे स्वसन्निहिततत्पार्श्वावच्छेदेन फलं जनयिष्यति । यतः पट्टिकान्तरस्य काचलग्ने पृष्ठे ऽपचयप्रयुक्तं विद्युद्वैषम्यं भवति बाह्ये तु पृष्ठ उपचयप्रयुक्तं विद्युद्वैषम्यमुत्पद्यते । यदि चेयं

पट्टिका विद्युदपगममार्गभूतपदार्थान्तरसम्बन्धरहिता स्यात् तदा तत्रत्यं विद्युद्वैषम्यं सततमनुवर्तेत । यदि तस्याः पट्टिकाया बाह्यं पृष्ठं विद्युदपगममार्गभूतपदार्थद्वारा भूसम्बद्धं स्यात् तदा तद्गता ऽधिका विद्युद् भूमिं प्रविशेत् । यत्परिमाणं चोपचयप्रयुक्तं विद्युद्वैषम्यं पूर्वस्यां पट्टिकायां वर्तते तत्परिमाणमेवापचयप्रयुक्तं विद्युद्वैषम्यमपरस्यां पट्टिकायां वर्तेत । अथ यदि द्वयोरपि पट्टिकयोः पृष्ठे केनचिद्धातुसूत्रादिना विद्युन्मार्गेण सम्बद्धे स्यातां तर्हि तत्र स्फुलिङ्गानां दर्शनं चटचटाशब्दश्रवणं च स्यात् विद्युद्वैषम्यकारकयन्त्रादिवोत्पन्नो बलवानाघातश्चानुभूयेत यत एकस्मिन् धातुखण्डे राशीभूता विद्युदपरधातुखण्डनिर्गताया विद्युतः स्थानं पूरयितुं धातुसूत्रादिद्वारा सवेगं याति ॥

। २ । यदि च कश्चिद् धातुसूत्रद्वारा तयोः पट्टिकयोः सम्बन्धमकृत्वा वामदक्षिणहस्तद्वारैव तदुभयसम्बन्धं कुर्यात् तर्हि विद्युदाघातं सन्धिबन्धकम्पहेतुमनुभवेत् तेन च तं द्वारीकृत्य विद्युद् गच्छतीत्येतदनुमीयते ॥

। ३ । तथा यदि शतं पुरुषा एकावलम्बितापरहस्तक्रमेण मालाबन्धेन तिष्ठन्ति तेषु च प्रथम उक्तयोर्लौहपट्टिकयोरेकामन्त्यश्चापरां स्पृशेत् तर्हि सर्वे पुरुषाः प्रत्येकं शतपत्रभेदवद् युगपदेवाघातं प्रत्यक्षीकुर्युः । अतश्चेदमनुमीयते यद् विद्युत् पुरुषमण्डलद्वारा ऽनुपमशीघ्रतया गच्छति । सेयं विद्युद् बाणमुक्तव्यवहितपूर्वं धनुषो ज्येवात्यन्ताततत्वावस्थायां स्थिता सहसा

ऽऽत्मानं मुञ्चतीव । सकृद्भ्रमणेन चास्याः कार्यजनकत्वं क्षीणं भवति । अपिचान्याभिरपीतिकर्तव्यताभिर्विद्युत् तथा सततं वैषम्यं भजते येन सा नदीव सततं प्रवहन्ती दृश्यते । एवंविधश्च विद्युद्वैषम्यप्रादुर्भावो विजातीयधातुसंयोगाद् विशेषतो जायते ॥

। ४ । एतदेव सूत्रेणाह ॥

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भिन्नजातीयधातुसंयोगो विद्युत्साम्यविघातं कुर्वन् विद्युद्वैषम्यमुत्पादयति ॥ ६२ ॥

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। १ । यथा जिह्वाया उपरि रजतखण्डमधश्च दस्तखण्डं तथा निधेयं यथा तयोः संयोगो न स्यात् तस्मात्तयोः संयोगकरणे च सहसैव तीक्ष्णो रसोऽनुभूयते । यदि चैते दस्तरजतखण्डे जिह्वाया अध उपरि च विन्यस्य ताम्रसूत्रद्वारा सम्बद्धे क्रियेते तर्ह्यप्येष एव रसो ऽनुभूयते ॥

। २ । अथ गन्धकद्रवस्य तद्दशगुणजलस्य च मिश्रणेन सहिते पात्रे दस्तस्य ताम्रस्य च पत्रं स्थापनीयं । यावत् तयोः संयोगो न भवेत् तावद् वैषम्यविशिष्टविद्युत्कार्याणि न दृश्यन्ते । परन्तु यदैव तत्पत्रद्वयोपरिभागयोः साक्षाद् वा ताम्रसूत्रादिपरम्परया वा योगो भवति तदा ताम्रपत्रसन्निधौ वायुविशेषकृतो बुद्बुदसमूहो निर्याति । तथा पत्रद्वयसंयोगहेतुभूतस्य ताम्रसूत्रस्यात्यन्तदीर्घत्वे ऽपीमानि कार्याणि जायन्ते ॥

। ३ । यदि च तत्पत्रद्वयसंयोगहेतुभूतं सूत्रं गुरुतमम्यं स्यात् तर्हि तत् तत्संयोगसमकालमेव तप्तं स्यात् । अतो यदि नितान्तदीर्घयोस्ताम्रसूत्रयोरेकं प्रान्तद्वयं गुरुतमसूत्रे निबध्येतापरं च तत्प्रान्तद्वयं पूर्वोक्तदस्तताम्रपत्रद्वये योज्येत तदा सहसैव गुरुतमसूत्रं पूर्ववत् तप्तं स्यात् । अतो यदि द्वे ताम्रसूत्रे शतहस्तदीर्घे गृहीत्वा तदग्रयोर्लघुतमसूत्रं निबध्येत तर्हि यत्र वयं वर्तामहे ततः शतहस्तदूरे यथेच्छं तद्गुरुतमसूत्रं तापयितुं शक्यते । यदि च तद् गुरुतमसूत्रं पूर्वमेवाग्निशस्त्रचूर्णपुटके निहितं स्यात् तर्हि ताम्रसूत्रस्यापरप्रान्तयोर्दस्तताम्रपट्टिकाग्रयोजनेनेच्छासमकालमेव तच्चूर्णं दग्धुं शक्यते । सोऽग्निशस्त्रचूर्णपुटको यदि जलाभ्यन्तरे स्यात् तदापीदं कार्यं जायत इत्यतोऽनयेतिकर्तव्यतया गङ्गादिनदीषु नौयात्राप्रतिबन्धकारिणां तज्जलमग्नवृक्षादीनामुद्धरणं भवितमर्हति ॥

। ४ । यदि कौशेयसूत्रवेष्टितानां कुण्डलिकानां मध्ये स्वच्छो लोहखण्डो निधीयते ततश्च तस्य ताम्रसूत्रस्याग्रद्वयं दस्तताम्रपट्टिकया संयोज्यते तर्हि तस्मिन् लोहखण्डे लोहान्तराकर्षणशक्तिरुत्पद्यते ताम्रसूत्रयोर्दस्तताम्रपट्टिकाविश्लेषे तु सा शक्तिर्नश्यति । पुनः संश्लेषे पुनरुत्पद्यते । इयमेव शक्तिश्चुम्बकशक्तिरित्युच्यते ॥

। ५ । अथ प्रसङ्गाच्चुम्बकधर्मान् वक्तुमुपक्रमते । तत्रादावकृत्रिमचुम्बकलक्षणमाह ॥

लोहखण्डाकर्षणशक्तिमान् खनिजलोहपाषाणो
ऽकृत्रिमचुम्बक इत्युच्यते ॥ ६३ ॥

। १ । अथ कृत्रिमचुम्बकलक्षणमाह ॥

अकृत्रिमचुम्बकघर्षणाल्लोहखण्डाकर्षणानुकूलश-
क्तिमांल्लोहखण्डः कृत्रिमचुम्बकइत्युच्यते ॥ ६४ ॥

। १ । उभयविधोऽपि चुम्बको लोहखण्डान्तरे चुम्बकश-
क्त्युत्पादनेन स्वगतं चुम्बकत्वं लेशतोऽपि न जहाति ॥

। २ । अथ चुम्बकस्य व्यावहारिकं फलमाह ॥

चुम्बकीकृतस्य लोहखण्डस्य केन्द्रबिन्दौ साधारे
सति स कञ्चित् कालं भ्रमित्वा विरमति तदा
केवलं दक्षिणोत्तरे एव दिशौ सूचयति ॥ ६५ ॥

। १ । केन्द्रबिन्दौ साधारे सतीत्यादि । तद् यथा तादृशलो-हखण्डस्य केन्द्रं सूत्रेण लम्बयेदथवा तथा मन्दं जलपृष्ठे तादृशं लोहखण्डं निदध्यात् यथा तरेत् तथाकृते च विना दक्षिणो-त्तरस्थितिं स कदापि भ्रमणान्न विरमति । परन्त्वस्य विषयस्य प्रदर्शने ऽत्यन्तोपयुक्तेतिकर्तव्यतेयमस्ति । यथा । कस्यचित्

तीक्ष्णाग्रकीलस्योपरि तादृशं लोहशकलं केन्द्रबिन्दुना निदध्यात् स च निष्प्रतिबन्धं तमक्षंपरितः क्षणं भ्रमित्वाऽन्ते दक्षिणोत्तर-संस्थो भवति ॥

। २ । एवंविधेन च यन्त्रेण पान्थस्तिरोहितनक्षत्रायामपि रात्रौ दिशो निर्देष्टुं शक्नोति । एवं यदा नाविकाः समुद्रे-गच्छन्तः स्थलं द्रष्टुं न शक्नुवन्ति तदैतद् यन्त्रं तेषां परमोपकारि भवति तेनैव कारणेनैतद् यन्त्रं नाविकसूचीत्युच्यते ॥

। ३ । चुम्बकीकृतलोहखण्डस्य द्वौ प्रान्तौ सर्वदा स्वसंस्था-नेन पृथिव्या दक्षिणोत्तरध्रुवयोः सूचकौ भवतोऽतएव तौ चु-म्बकस्य दक्षिणोत्तरध्रुवावुच्येते ॥

। ३ । अथ चुम्बकस्य धर्मान्तरमाह ॥

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सनामकौ चुम्बकयोर्ध्रुवौ परस्परमुत्सारयतो वि-
नामकौ च परस्परमाकर्षतः ॥ ६६ ॥

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। १ । तथाहि यदि सूत्रलम्बितचुम्बकस्योत्तरध्रुवसन्निधौ चुम्बकान्तरस्योत्तरध्रुवो नीयते तर्हि पूर्वस्योत्तरध्रुवो दूरमप-सरति एवं दक्षिणध्रुवोऽपि । परन्तु यदि हस्तस्थचुम्बकस्योत्त-रध्रुवः सूत्रावलम्बितस्य दक्षिणध्रुवसमीपं नीयते तर्हि पूर्वस्य दक्षिणः परिहृत्य हस्तस्थचुम्बकस्योत्तरध्रुवेण सङ्गन्तुमागच्छेत् । एवमेव यदा हस्तस्थस्य दक्षिणः सूत्रावलम्बितस्योत्तरं प्रति नी-

यते तदाऽपि समानमेव फलं भवतीति ॥

।२। अथ पूर्वोक्तरीत्या गन्धकद्रवनिमज्जिताधरभागयोर्दस्ततास्रपत्रयोस्तास्रसूत्रद्वारा सम्बद्धोर्द्ध्वभागयोः सतोः प्रतिक्षणं सततं विद्युद्वैषम्यं जायते तादृशं च विद्युद्वैषम्यं विद्युत्प्रवाह इत्यच्यते तद्योगाच्चुम्बकधर्मस्य विकारो भवति तमहा ॥

केन्द्रालम्बितश्चुम्बको विद्युत्प्रवाहबलेन दक्षिणोत्तर-
संस्थानं विहाय पूर्वपश्चिमसंस्थानंभजते ॥ ६७ ॥

।१। पूर्वपश्चिमसंस्थानमिति । तद्यथा । दस्तपत्रं तास्रपत्रं चोभे जलमिश्रितगन्धकद्रवे निमज्जनीये । हस्तशतद्वयमितं च तास्रसूत्रं मध्यप्रदेशावच्छेदेन कुण्डलीसमुदायात्मकं कर्तव्यम् । स च कुण्डलीसमुदाय उक्तपत्रद्वयगर्भात् पात्राद्धस्तशतद्वयान्तरे दक्षिणोत्तरसंस्थोनिधेयः । तस्य च मध्ये केन्द्रालम्बी चुम्बको निधातव्यः । स च स्वभावादेव दक्षिणोत्तरसंस्थः स्थास्यति । ततो मध्ये कुण्डलीकृतस्य तस्य तास्रसूत्रस्य द्वौ प्रान्तौ दस्ततास्रपत्रयोः प्रत्येकमेकैकश्येन योजनीयौ । तत्क्षण एव च कुण्डलिकामध्यवर्ती चुम्बकः पूर्वपश्चिमसंस्थो भविष्यति तत्संयोगाभावे च पुनर्दक्षिणोत्तरसंस्थो भविष्यति ॥

।२। अथैवं निरूपितयोर्विद्युच्चुम्बकयोस्तत्त्वज्ञानस्य व्या-

वहारिकफलभूतं विद्युद्दूरलेखकनामकं यन्त्रं निरूपयितुमुप-
क्रमते ॥

केन्द्रलम्बिनश्चुम्बकस्य विद्युत्प्रवाहकृतः स्वाभा-
विकस्थितेर्विपर्यासो विद्युद्दूरलेखकनामकयन्त्रस्य
लमूम् ॥ ९८ ॥

। १ । तत्र दूरलेखकं नामातिदूराच्छीघ्रं वृत्तान्तज्ञापनस्योपायः। यथा। यदा कस्याश्चिद् बाष्पनौकायाः काशीप्राप्तिं द्वित्रक्रोशदूरे ज्ञापयितुमिच्छन् कश्चिद् गङ्गातीरस्थं यवननिर्मितं मनोहरइतिप्रसिद्धमत्युच्चं चैत्यस्तम्भमारुह्य कामपि पताकां स्थापयति। सा च बाष्पनौकागमनद्योतकत्वेन यैः सङ्केतिता तेभ्यो नौविशेषागमनं ज्ञापयति ॥

। २ । अपिच तस्याः पताकाया विविधानि चालनानि बाष्पनौकानां तत्तद्विशेषज्ञापने समर्थानि भवन्ति यदि पूर्वं द्रष्टृदर्शकयोः सङ्केतस्तथा स्यात् तथाहि एकवारं पूर्वां दिशं प्रति गमनं पुनः प्रत्यागमनं च कस्याश्चिन्नौकाया द्योतकं। द्विवारं तदन्यस्याः। त्रिवारं तदपरस्या इत्यादिः सङ्केतः सम्भवति। तथाच यथा पताकया पूर्वगृहीतसङ्केतानुसारेण नानाविधा बाष्पनौका ज्ञापयितुं शक्यन्ते तथा पूर्वगृहीतसङ्केतानुसारेण वर्णमालिकान्तर्गता नानावर्णा अपि तया ज्ञापयितुं शक्यन्ते युक्ति-

तौल्यात् ॥

। ३ । तदेतत् पताकया नानावर्णज्ञापनं विद्युद्रेखकयन्त्रव्यापारेण वस्तुतो निष्पद्यमानस्य कार्यस्य सम्भवोदाहरणमात्रम् ॥

। ४ । अथ प्रदर्शितपताकावच्चुम्बकीकृतलोहशकलचालनैर्वृत्तान्तज्ञापने ये सङ्केतभेदा स्त इह न प्रतिपाद्यन्ते । तेषामनन्तभेदानां पुरुषकृतव्यवस्थाविषयत्वात् । प्रस्तुतस्य गतिस्थितिविचारस्याविषयत्वाच्च । किन्त्वेकपुरुषकृतेन सङ्केतद्वारा बोधकेन चुम्बकीकृतलोहशकलचालनेन हेतुना किमपि वृत्तमनेकशतक्रोशदूरस्थस्य पुरुषान्तरस्य ज्ञेयं भवतीत्यत्र हेतुरिह प्रतिपाद्यते ॥

। ५ । तत्र विद्युद्वैषम्यजनकयन्त्रमधितिष्ठतः पुरुषस्येच्छानुसारेण ताम्रसूत्रकुण्डलीसमुदाये विद्युत्प्रवाहोत्पादनेन चुम्बकीकृतलोहशकलस्थितिविपर्यासप्रकारः पूर्वं प्रदर्शितः । तस्यास्य लोहशकलस्थितिविपर्यासस्यात्यन्तशैघ्र्ये सर्वात्मना तत्ताम्रसूत्रदैर्घ्यभेदेन कोऽपि भेदो न भवति । तथाहि । तल्लोहशकलं कलिकातानगरेऽस्तु । तादृशलोहशकलं परितो वर्तमानताम्रसूत्रकुण्डलिकाया अग्रद्वयं च काश्यामस्तु । तथाहि यथा शतहस्तान्तरे वर्तमानयोस्ताम्रसूत्राग्रयोर्योगादव्यवहितोत्तरमेव ताम्रसूत्रकुण्डलिकान्तर्वर्ति तल्लोहशकलं चलति तथैव काशीस्थयोस्ताम्रसूत्राग्रयोर्योजने तदव्यवहितोत्तरमेव कलिकातास्थ-

स्य ताम्रसूत्रकुण्डलीसमुदायस्य मध्यवर्ति लोहशकलं चलति । एवमेव नन्दननगरस्य काश्याश्च ताम्रसूत्रद्वारा योगे सति फलं समानमेव भविष्यति ॥

। ६ । अथ यदोक्तपताकाचालनानि बाष्पनौविशेषागमज्ञापनाय क्रियन्ते तदा यदि गृहीतसङ्केतो ऽपि पुमान् प्राथमिकानि चालनानि न पश्यत्यन्त्यं च दैवगत्या पश्यति तर्ह्येकचालनद्योत्यत्वेन सङ्केतिताया नाव आगमनविषयकस्तस्य भ्रमः स्यात् । अतस्तादृशभ्रमनिरासायादौ शतघ्नीनादं कृत्वा पताकाचालनं कार्यं येन द्रष्टारः सावधाना भूत्वा पश्येयुः । परन्तु चुम्बकीकृतलोहशकलचालनेन वार्ताज्ञापनस्थले ऽप्युक्तविधो भ्रमः सम्भवति तन्निवारणायोक्तविध उपायस्तु न सम्भवति । काश्यां जातस्य शतघ्नीनादस्य कलिकातानगरप्राप्त्यसम्भवात् । तथाच कथमस्मिन् विषये उक्तविधभ्रमनिरासः केनोपायेन सम्भवतीति ॥

। ७ । अत्रोच्यते । किमपि लोहशकलं विद्युत्प्रवाहेण चुम्बकतां प्रापयितुं शक्यत इति पूर्वमुक्तं तच्च चुम्बकत्वं विद्युद्वैषम्यकारकयन्त्रेण तयोस्ताम्रसूत्रयोर्योगे कृते जायते विश्लेषे तु कृते निवर्तते । तथाच काशीनगरमारभ्य विततैस्ताम्रसूत्रैर्निर्मितासु कलिकातास्थासु कुण्डलिकासु तल्लोहशकलं तथा समुचितप्रकारेण निधेयं यथा तल्लोहमयघण्टाया लोलारूपं भवेत् । तथासति च यदैव काश्यां विद्युद्वैषम्यकारकयन्त्रे ताम्रसूत्रयो-

योगः क्रियते तदैव कलिकातानगरे घण्टालोलाभूतं लोहश-कलं चुम्बकीभूतत्वाद् घण्टापुटेनाकृष्टं सत् तस्मिन्नभिघातं करोति । काश्यां तत्संयोगापाये च कलिकातास्था घण्टालोला पूर्ववद् घण्टापुटसम्बन्धरहिता तिष्ठति । पुनः काश्यां तत्संयो-गसम्पादने पुनः कलिकातानगरे घण्टानादो जायते । अनया रीत्या पूर्वं कलिकातास्थदूरलेखकयन्त्राध्यक्षस्य पुरुषस्य साव-धानतां सम्पाद्य तत उत्तरं काशीतः कलिकातास्थचुम्बकीकृ-तलोहशकलचालनद्वारा तत्र वार्ता ज्ञाप्यन्ते इति ॥

। ८ । अथान्यं विद्युद्वैषम्योपायमाह ॥

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उष्णतया विद्युतः साम्यविघाताद् वैषम्यं जायते ॥ ६९ ॥

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। १ । तथाहि विद्युद्वैषम्यज्ञापकयन्त्रस्योपरि जलपूर्णं धातु-मयं पात्रं विन्यस्य तस्मिन् ज्वलन्तमङ्गारं पातयेत् तथासति तद्यन्त्रस्थयोर्विद्युद्वैषम्यज्ञापकयोर्विश्लेषो विद्युद्वैषम्योत्पत्तिं ज्ञा-पयति ॥

। २ । अस्य प्रसिद्धं फलमाह ॥

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जलादुष्णताबलेनोत्थिता मेघा विद्युद्वैषम्यविशिष्टा भवन्ति ॥ ७० ॥

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। १ । अतएव मेघेभ्यः सार्वजनीनानि प्रकाशशब्दाघाता-दीनि वैषम्यविशिष्टविद्युत्कार्याणि प्रादुर्भवन्ति ॥

। २ । इत्थञ्च तृणमणिशक्तेः प्रसिद्धविद्युतश्च तादात्म्यं परीक्षाभिरुपपादितम् । अपिचेयमपि परीक्षा तत्र मानं तथाहि विद्युद्वैषम्यज्ञापकयन्त्राग्रे ऽतिदीर्घसूत्रस्यैकं प्रान्तं बध्वा ऽपरं बाणस्यान्ते बध्नीयात् ततः स बाणो महीतलसन्निहिते मेघे मोक्तव्यः । तथा कृते च विद्युद्वैषम्यज्ञापकयन्त्रसम्बन्धिनौ ज्ञापकौ वियुक्तौ भवतः ॥

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केचित् प्राणिनो ऽपि विद्युद्वैषम्यकराः सन्ति ॥ ७१ ॥

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। १ । यथा । युरोपदेश उपलब्धो वैद्युतिकशङ्कुचिः । अमेरिकादेश उपलब्धा वैद्युतिककुञ्चिका । गङ्गायामुपलब्धो वैद्युतिकपाठीन इत्याद्याः । एते हि विद्युद्वैषम्यानुकूलया स्वशक्त्या स्वभक्ष्यान् जलजन्तून् मूर्च्छयित्वा गृह्णन्ति तथा स्वशत्रून् मूर्च्छयित्वा ऽऽत्मानं रक्षन्ति ॥

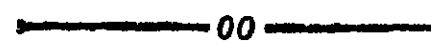
॥ ❋ ॥ इति समाप्तं विद्युत्प्रकरणम् ॥ ❋ ॥

। २ । तदेवं चुम्बकीकृतलोहशकलस्य गतिस्थिती गतिस्थितिनिरूपणार्थमारब्धस्यास्याध्यायस्य विषयभूतयोर्गतिस्थित्योरुदाहरणविशेषौ भवतः परन्तु गुरुत्वरहितपदार्थानां कार्येषु मध्ये

क्वचिद् देशभेदादधिकं किमपि कदाचिद् दृश्यते । यथा । अत्यन्तानलसंयोगेन जलस्यावयवा वाष्पीभवन्तः केवलं देशभेदमासादयन्ति पुनश्चाग्निसंयोगप्रयुक्तोष्णताया अपगमे जलभावं प्राप्नुवन्ति परन्तु तथाविधा पुनः पूर्वावस्थाप्राप्तिरग्निसंयोगाद् दग्धानामिन्धनानां नास्ति नह्युष्णताया अपगमे क्वापीन्धनानि पुनरिन्धनभावं प्राप्तानि दृष्टानि । अतो ऽनुमीयते गतिस्थितिविचारविषयीभूताद् विकारादधिको विकारो ऽग्निदग्धानामिन्धनानां भवतीति ।. सच विकारो रासायनिक इत्युच्यते तस्य विस्तरेण वर्णनमुत्तराध्याये करिष्यते इति ॥



इति श्रीमज्जेम्स्ब्यालन्टाइनविरचितायां न्यायकौमुद्यां गतिस्थितिविचारो नाम चतुर्थो ऽध्यायः ॥



। १ । पूर्वस्मिन्नध्याये बाह्यद्रव्यगतिस्थिती सहेतुके स्वस्वनियमसहिते सोदाहरणे प्रदर्श्य तद्विलक्षणानां बाह्यद्रव्यगतरासायनिकविकाराणां निरूपणं कर्तुं प्रतिज्ञातं । तत्र विकारो नाम सिद्धधर्मान्यधर्मप्राप्त्यनुकूलो द्रव्याणां व्यापारः यथा पूर्वदेशपरित्यागपूर्वकमुत्तरदेशम्प्रति गतिः । विकाराणां रासायनिकत्वं च रसायनाख्यशास्त्रविषयत्वं तज्ज्ञावच्छेदकरूपज्ञानं विना दुर्ज्ञेयमिति प्रथमं विकाराणां रसायनाख्यशास्त्रविषयतावच्छेदकं रूपमाह ॥

जीवनशक्त्यप्रयोज्यस्थायिधर्मपर्यवसन्नो देशभेदा-न्यो विकारो रसायनाख्यशास्त्रविषयः स एव रसा-यनिकविकार इत्युच्यते ॥ १ ॥

। १ । स्थायीत्यादि । धर्मेषु स्थायित्वं निमित्तकारणापग-मानधीननिवृत्तिकत्वं तथाहि वह्निदग्धानामिन्धनानां यो भस्म-त्वादिर्धर्मो जायते स स्थायी स्वनिमित्तस्य वह्निसंयोगस्यापगमे ऽपि तस्यानिवृत्तेरतस्तस्मिन् पर्यवसन्नो य इन्धनानां व्यापारस्स रसायनाख्यशास्त्रस्य विषयः । यस्त्वत्यन्ताग्निसंयोगाज्जलानां बाष्पीभावः स स्वनिमित्तस्य वह्निसंयोगस्यापगमे निवर्तते ऽत-स्तत्र पर्यवसन्नो यो जलस्य व्यापारः स न रसायनाख्यशास्त्रस्य विषयः किन्तु गतिस्थितिविचारस्यैवेति । तथाच निमित्तकार-णापगमानधीननिवृत्तिकेषु जीवनशक्त्यप्रयोज्येषु धर्मेषु पर्यवस-न्नानां देशभेदातिरिक्तानां बाह्यद्रव्यव्यापाराणां यच्छास्त्रं तदेव रसायनाख्यं शास्त्रमिति बोध्यम् ॥

। २ । अथ जले लीनस्य तुत्थस्य यो दार्व्याभावो जायते स स्वनिमित्तस्य विलोडनदण्डस्यापगमेऽपि न निवर्तत इति तत्र पर्यवसन्नो यस्तुत्थस्य व्यापारः स रसायनशास्त्रविषयः स्यादिति चेन्न तदा ऽपि तुत्थीया रूपरसादयो ऽविकृताः सन्ति केवलं जलावयवमिश्रणेन तुत्थावयवानां परस्परमसान्निध्यं जातं तेनैव

दार्ढ्याभाव: प्रतीयते दार्ढ्यं प्रति तद्द्रव्यावयवानां परस्परसान्निध्याधिक्यस्यापेक्षितत्वात् ॥

। ३ । ननु भुक्तजीर्णेऽन्ने मांसास्थ्यादिभावो भवति सोऽपि स्वनिमित्तापगमे न निवर्तत इति तत्र पर्यवसन्नो योऽन्नस्य व्यापार: स रसायनशास्त्रविषय: स्यात् । सत्यम् । परन्तु यथा रासायनिकविकारस्थलेऽपि देशभेदविशेषा जायन्ते न च तावता ते गतिस्थितिविचारस्यैव विषया इत्युच्यन्ते तथा ये केचिद् रासायनिकविकारा जीवनशक्तिवशाज्जायन्ते ते न रसायनशास्त्रमात्रविषया इत्युच्यन्ते । तेच जीववस्तुतत्त्वविचाराख्य उत्तरप्रकरणे विवेचयिष्यन्ते ॥

। ४ । अथैतच्छास्त्राभिमतं बाह्यद्रव्याणामाद्यं विभागमाह ॥

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द्रव्याणि द्वेधा मिश्रामिश्रभेदात् ॥ २ ॥

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। १ । मिश्रद्रव्यं यथा पारदगन्धकात्मकं कपिशीर्षकम् ॥

। २ । अमिश्रद्रव्यं यथा गन्धको यस्य मिश्रितत्वविनिगमको न ज्ञायते ॥

। ३ । मिश्रद्रव्याणि अमिश्रद्रव्याख्यानि असंख्यानि । अमिश्रद्रव्याणि षष्ट्यधिकानि । तेषां तावद्भेदा उच्यन्ते ॥

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अमिश्रद्रव्याणि द्वेधा धातुरूपाण्यधातुरूपाणिचेति ॥ ३ ॥

।१। सुवर्णलोहपारदादिद्रव्याणि धातुरूपाणि । गन्धकादीन्यधातुरूपाणि ॥

अधातुरूपामिश्रद्रव्याणि द्विधा वायुरूपाण्यवायुरूपाणिचेति ॥ ४ ॥

।१। वायुर्नामऽसाधारणसंकोचकाले साधारणोष्णतां विनाप्यनियतदेशव्यापनशक्तिमान् द्रव्यविशेषः । उष्णीकृतजलबाष्पमनियतदेशव्यापनशक्तिमद्भवति किन्त्वसाधारणोष्णताभावे तद्व्यापनशक्तिर्नश्यतीत्येतावांस्तत्र भेदः ॥

।२। वायवः साधारणादिभेदैर्बहुविधाः । तत्र यः प्राणिनां श्वासोच्छ्वासोपयुक्तः स साधारणसंज्ञः । अन्ये च वायुविशेषाः कथ्यन्ते ॥

अमिश्रवायुविशेषाश्चत्वारो भवन्ति ॥ ५ ॥

।१। तेषां नामानि । प्राणप्रदः । जीवान्तकः । जलकरः । हरितश्चेति ॥

।२। प्रथमो वायुविशेषोऽतः प्राणप्रद उच्यते यतो न तं विना प्राणिनो जीवितुं शक्नुवन्ति । अस्मिन् न कश्चन स्वादः

नापि गन्धः । अनेन पूर्णस्य काचपात्रस्य वर्णो न साधारण-वायुपूर्णकाचपात्रवर्णाद्भिन्नः । कस्तर्हि सामान्यवायोः प्राण-प्रदवायोश्च भेद इति चेच्छ्रूयताम् । दाह्यद्रव्याणि प्राणप्रदवायौ अतिशयेन ज्वलन्तीत्यस्ति तत्र भेदः ॥

। ३ । अचिरादुपशमिष्यज्ज्वलने काष्ठखण्डे प्राणप्रदवायौ धृते तत्काष्ठखण्डमतिशयेन ज्वलितमारभते ॥

। ४ । अत्र लोहो ऽपि शुष्केन्धनवत् ज्वलति ॥

। ५ । प्रकाशदसंज्ञको ऽस्थ्यारम्भकावयवविशेषः प्राणप्रद-वायौ दीपितः सूर्यवत्प्रकाशते नचैवं साधारणवायौ ॥

। ६ । प्राणप्रदवायुं विना प्राणिनो न जीवन्तीत्युक्तं तद-नुपपन्नं साधारणवायौ प्राणिजीवनदर्शनादिति चेन्न साधारण-वायौ प्राणदवायोः सद्भावात् । नच साधारणवायौ ज्वलनसा-मग्रीविशिष्टानां लोहादीनां दाहापत्तिस्तद्धेतोः प्राणप्रदवायोः सद्भावादिति वाच्यं । तत्रत्यप्राणप्रदवायोर्जीवान्तकवा ुना त-दीयज्वलनशक्त्युत्कर्षप्रतिबन्धकेन मिश्रितत्वादतिशयितदाहा-भावोपपत्तेरिति ॥

। ७ । एवं द्वितीयो जीवान्तकाख्यो वायुभेदो न गन्धवान्न रसवान्नच काचपात्रसम्भृते ऽप्यस्मिन् रूपमुपलभ्यते यथा प्रथ-मे । कस्तर्ह्यस्य प्रथमाद्विशेष इति चेत् शुद्धे जीवान्तकवायौ प्र-क्षिप्तं ज्वलद्द्रव्यमाशु निर्वाणम्भवतीत्येको विशेषः । अथ साधा-रणवायुर्यदि जीवान्तकवायुमात्ररूपः स्यात्तर्हि न किञ्चिदपि

ज्वलेत् । यदि च प्राणप्रदवायुमात्ररूपस्तर्ह्येकस्फुलिङ्गस्पर्शात्सर्वं भस्मसाद्भवेदिति । मैवं । साधारणवायोर्निर्णीतपरिमाणविशेषानुसारेणोक्तवायुद्वयमिश्रिततया पूर्वोक्तदोषद्वयाभावात् ॥

। ८ । तच्च परिमाणं जीवान्तकवायोश्चत्वारोंऽशाः प्राणप्रदवायोरेकोंऽशः साधारणवायुघटको भवतीति । अत्र किं मानमिति चेत् प्रत्यक्षपरीक्षासहकृतमनुमानमिति ब्रूमः । तद्यथा । जलपूर्णे पात्रे ज्वलन्ती वर्त्तिका तथा स्थाप्या यथा जलोपरि तरेत् ततस्तदुपरि घण्टाकारं काचपात्रपिधानं तथा स्थापनीयं यथा तस्याधरान्तो जले किञ्चिन्निमज्जेत । एवं कृते अचिराज्ज्वलनोपकारोपक्षीणशक्तौ प्राणप्रदवायौ विकृते वर्त्तिका निर्वाति जलञ्च तत्पात्रान्तःप्रदेशे बहुपञ्चमभागपर्यन्तमूर्ध्वं याति तावति प्रदेशे वायोरभावञ्चानुमापयतीति ॥

। ९ । तृतीयोऽपि वायुप्रभेद उक्तवायुद्वयवद् गन्धरसरहितः काचपात्रसम्भृततादृशायामनुपलभ्यमानरूपश्च । प्राणप्रदवायुना सह तस्य संयोगाज्जलमुत्पद्यते तत्सूचनार्थं एतद्वायोः संज्ञा जलकरः स्यात् ॥

। १० । दाहविषयेऽयं प्राणप्रदवायोर्विपरीतधर्मा भवति । यदि ज्वलन्ती वर्त्तिका जलकरवायौ क्षिप्यते तदा झटिति निर्वाति जलकरवायुश्च दीप्यते ॥

। ११ । अयञ्च सर्वेष्वद्ययावज्ज्ञातवस्तुषु मध्ये प्रकृष्टलघुर्भवति । अनेन पूर्णः पेशीविशेषः पक्षिगम्यप्रदेशादूर्ध्वं याति ।

एतद्वायूपष्टब्धेन महाप्रमाणेन पेशीविशेषेण कतिपयपुरुषस- हितो मञ्चविशेषो बहूच्चप्रदेशोपरि नेतुं शक्यते ॥

। १२ । एवं चतुर्थो वायुभेदो हरिताख्य उक्तेभ्यो ऽमिश्र- वायुविशेषेभ्यो बहुभिर्विशेषैर्विशिष्यते । अस्य वर्णो हरित्मायो रसगन्धौचात्यन्तोत्कटौ दुःखप्रदौच ॥

। १३ । वक्ष्यमाणाः कतिचिद्द्रव्यविशेषा एतद्वायुसंयोगमा- त्रेण ज्वलन्ति । ते तथा । ताम्रस्यातिचिपिटपत्रं प्रकाशदसं- ज्ञकश्च उष्णीकृतः पारदादिश्चेति ॥

। १४ । अयं प्राणिनां जीवननाशको वृक्षजातीनां शैत्य- हेतुश्च । अतएव वस्त्रादिशुक्लीकरणे परमोपयोगी । किञ्च रोगिशालाकारागारादिष्वयं वायुर्महत उपकाराय भवति त- त्रत्यानां रोगवशात् कारणान्तराद्वा जन्यपूतिगन्धादिनाशक- त्वात् ॥

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धातुवाय्वतिरिक्तान्यमिश्रद्रव्याणि नव भवन्ति ॥ ६ ॥

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। १ । एतानि तेषां नामानि । यथा । अङ्गारः । टङ्क- करः । अग्निप्रस्तरकरः । गंधकः । चान्द्रः । प्रकाशदः । पूतः । अरुणः । काचशकरः ॥

। २ । ध्मातकाष्ठस्य दहने जलेन निर्वाणे ऽवशिष्टोऽङ्गारो भवति श्यामवर्णः ॥

। ३ । टङ्कावयवः कपिशचूर्णविशेषः टङ्ककरः ॥

। ४ । लोहखण्डाघातादग्निजनकस्य प्रस्तरविशेषस्यावयवभूतः कपिशवर्णचूर्णविशेषोऽग्निप्रस्तरकरः ॥

। ५ । दाह्यः पीतवर्णः सर्वज्ञातो द्रव्यविशेषो गन्धकः ॥

। ६ । बहुभिर्धर्मैर्गन्धकतुल्यो द्रव्यविशेषश्चान्द्रः ॥

। ७ । सिक्थकसदृशरूपः तमसि प्रकाशः क्वथितजलोष्णतान्यूनोष्णसंयोगेन घर्षणादिना वा ज्वल्यो घर्षणज्वलनीयदीपशलाकानिर्माणोपयुक्तो द्रव्यविशेषः प्रकाशदः ॥

। ८ । कृष्णारुणोऽतिदुर्गन्धयुक्तो द्रवद्रव्यविशेषः पूतः ॥

। ९ । भास्वरकृष्णवर्णस्तीव्रगन्धवानग्निसंयोगेन बाष्पत्वदशायामरुणवर्णो द्रव्यविशेषोऽरुणः ॥

। १० । काचनाशकद्रवद्रव्यावयवत्वेन कल्पितो वस्तुविशेषः काचघ्नकरः ॥

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धातवः पञ्चाशदधिकाः ॥ ७ ॥

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। १ । तत्र सुवर्णरजतताम्रसीसकादयो धातवः कतिचित् सम्यग्विज्ञाताः कतिचिज्ज्ञातिदुर्मिला अनावश्यकनिरूपणाश्च । अतो येषां स्वरूपज्ञानमिहावश्यकं त एव धातवो ऽत्र निरूप्यन्ते ॥

। २ । सुवर्णाधिकगुरूरजतवर्णो गुरुतमाख्यो धातुः ॥

। ३ । पारदाख्यो धातुस्साधारणोष्णसंयोगे जलवद्द्रवरूपो ऽत्यन्तोष्णसंयोगे बाष्परूपोऽतिशीतदेशे तथा घनो यथास्य पत्राणि कर्तुं शक्यन्ते ॥

। ४ । रङ्गं रजतवर्णं सीसकवन्मृदु च ॥

। ५ । दस्ताख्यो धातुः सीसकवर्णोऽतितप्ततादृशायां साधारणवायौ दग्धः तूलवद्वायुना सर्वत्र क्षिप्यते ॥

। ६ । लघुतमाख्यो धातुरत्यन्तलघुत्वात् जले तरति । अयंच जले प्रक्षिप्तः स्वयमेव ज्वलति ॥

। ७ । लवणकराख्यो धातुर्जले क्षिप्तस्तरति परन्तु न लघुतमवज्ज्वलति ॥

। ८ । चूर्णकराख्यो धातुर्यस्माच्चूर्णमुत्पद्यते ॥

। ९ । अथ प्राणप्रदादिभिरमिश्रद्रव्यैर्भमण्डलोपलब्धानि सर्वाणि निर्मितानि सन्ति ॥

। १० । यद्द्रव्यं यद्द्रव्यजन्यं तद्द्रव्यस्य तत्तद्द्रव्यजन्यताबोधकपदेन व्यवहारोऽत्यन्तोपकारक इत्यत आह ॥

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रसायनशास्त्रे मिश्रद्रव्याणि स्वजनकतत्तद्द्रव्योत्पन्नत्वव्यञ्जकसंज्ञया व्यवहर्त्तव्याणि ॥ ८ ॥

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। १ । उदाहरणम् । हरितवायुना सह लवणकराख्यधातुमेलनात् साधारणलवणमुत्पद्यत इत्यत्र शास्त्रे साधारणलवणस्य

संज्ञा लवणकरहरितज इति । लवणस्य हरितवायोश्च मेल-
नाद् लवणस्योत्पत्तिरिति तदर्थः ॥

। २ । अथ यथोद्देशक्रमं प्राणप्रदवायुमारभ्य अमिश्रद्र-
व्याणां परस्परमेलनकार्याण्युच्यन्ते ॥

। ३ । साधारणवायौ प्राणप्रदवाय्वंशेन सह जीवान्तका-
ख्यवायोश्चत्वारोंऽशा भवन्तीत्युक्तं । अत्र साधारणवायुस्वरूपं
कार्यं रासायनिकं नोच्यते यतोहि तयोर्मेलनेऽपि विशेषो नो-
त्पद्यते । यत्र तु प्रत्येकज्ञातविशेषयोः पदार्थयोर्मेलनादुत्पन्नं
कार्यं नानुमानेन ज्ञातुं शक्यते तत्रैव रासायनिकसम्बन्धो भ-
वतीति पूर्वं सूचितम् ॥

। ४ । जीवान्तकवायुना सह प्राणप्रदस्य मेलनात् तत्तद्वायुप-
रिमाणभेदानुसारेण पञ्च कार्यविशेषा उत्पद्यन्ते। तेषूचोत्तरो-
त्तरमेकांशेन प्राणप्रदवाय्वाधिक्यं ज्ञातव्यम् । तेष्वाद्यो यथा ॥

। ५ । स जीवान्तकप्राणप्रदयोर्योगो यमुच्छ्वासक्रियाया वि-
षयीकुर्वन् पुरुषो ऽत्यन्तं हसति कतिपयक्षणपर्यन्तमुन्मत्त
इवच भवति ॥ द्वितीयो यथा ॥

। ६ । स उक्तवाय्वोर्योगो यो नीरूपः साधारणवायुसंयो-
गदशायां प्राणप्रदवायोरधिकं भागमाकर्षति रक्तवर्णश्च भवति ।
अत्राङ्गारः प्रकाशदश्च सवहुज्वालं ज्वलति अयंतु न श्वासो-
च्छ्वासक्रियाविषयो यत उरोवर्त्तिना साधारणवायुना संयोग-
काले पूर्वोक्तं रक्तवर्णं विषस्वभावं वायुविशेषं जनयति ॥ तृती-

यो यथा ॥

। ७ । स उक्तवाय्वोर्योगविशेषो यो महता प्रयत्नेन विना नार्जयितुं शक्यः अस्मिन्प्रकरणे विशेषतस्तस्य निरूपणं नावश्यकम् ॥ चतुर्थो यथा ॥

। ८ । पूर्वोक्तो रक्तवर्ण उक्तवाय्वोर्योगः यो जलेन संयुक्तस्तत्रैव लीयते ॥ पञ्चमो यथा ॥

। ९ । स उक्तवायुद्वययोगो यो जलमिश्रितात्यन्ताम्लरसविशेषस्वरूपो मांसं दहति यस्मिंश्च लोहादिकमपि लीयते ॥

। १० । अथ यद्द्रव्यं यद्द्रव्यजन्यं तद्द्रव्यस्य तद्द्रव्यजन्यताबोधकपदेन व्यवहारोऽस्मिन् शास्त्रे कर्त्तव्य इति पूर्वमुक्तं तथा उक्तवायुद्वयमिश्रणजनितानां परस्परमत्यन्तविलक्षणानां द्रव्याणां व्यवहारो मिश्रणावयवानामाधिक्यन्यूनत्वज्ञापकपदेनच कर्त्तव्यः । यथा । द्वितीययोगः प्रथमयोगमपेक्ष्याधिकेन प्राणप्रदवायुना विशिष्ट इतिहेतोः स प्राणप्रदवाय्वाधिक्यबोधकपदेन व्यवहर्त्तव्य इति ॥

। ११ । अथ नानाविधवस्तुसंयोगसम्बन्धिनां विविधधर्माणां निरूपणपूर्वकं उक्तविधसंकेतरचनोपायानां निरूपणं क्रियते ॥

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एतावत्परिमाणेनामुकेनैतावत्परिमाणममुकं संयुक्तं भविष्यति न न्यूनाधिकमिति नियमः केषुचि-

द्रव्येषु न दृश्यते ॥ ९ ॥

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। १ । यथा । एकपलमितं दुग्धं एककर्षमितेन जलेन संयुक्तं भवति एकपलमितं जलंच एककर्षमितेन दुग्धेन संयुक्तं भवति नचात्र कश्चिन्नियमो ऽस्तीति ॥

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क्वचित्तु न्यूनतायामनियम आधिक्येत्ववधिर्भवति ॥ १० ॥

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। १ । यथा । अमुकपरिमाणे जले ऽमुकपरिमाणं लवणं लीयते इत्येतस्मिन्विषये लवणस्याधिक्येऽवधिरस्ति नतु न्यूनतायाम् ॥

। २ । उक्तं वस्तुसंयोगस्य प्रकारद्वयं पूर्वप्रतिपादितहेतोर्नरसायनशास्त्रविषयो भवति ॥

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द्रव्ययोरासायनिकसंयोग एकस्यैकः परमाणुरपरस्यैकेनैव द्वाभ्यामेवेत्यादिक्रमेण संयुज्यते ॥ ११ ॥

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। १ । इत्यादि क्रमेणेति । अत्रचेदं प्रमाणं यद् रसायनशास्त्रीयविध्यनुसारेण संयुज्यमानयोरेकजातीयकार्योत्पादकयोः पदार्थयोः संयोगो नियतपरिमाणयोरेव भवति अपिच यत्र संयुक्ताभ्यां पदार्थाभ्यां नानाजातीयानि मिश्रणफलान्युत्पद्यन्ते तत्र द्वितीयादिमिश्रणे एकद्रव्यस्य प्रथमसंयोगस्थलीयमेव परि-

माणं अपरस्यतु प्रथमसंयोगस्थलीयपरिमाणापवर्त्यमेव परिमाणं भवति यथा । जीवात्मकवायुना सह प्राणप्रदस्य मेलनात् पञ्च मिश्रपदार्था उत्पद्यन्त इत्युक्तम् । तेषु प्रत्येकं जीवात्मकश्चतुर्दशमितो भवति प्राणप्रदश्च क्रमेण । ८ । १६ । २४ । । ३२ । ४० । एतत्परिमाणो भवति ॥

जलकरपरमाणोर्गौरवं रूपं प्रकल्प्य तदपेक्षया द्रव्यान्तरपरमाणूनां गौरवस्य सङ्ख्या व्यपदिश्यन्ते ॥ १२ ॥

। १ । यत्परिमाणकौ पदार्थौ प्रत्येकं जलकरवायुना संयुज्येते तत्परिमाणकावेव तौ मिथः संयुज्येते यथा । जलकरस्यैकेनांशेन हरिद्वायोः पञ्चत्रिंशद्भागाः संयुज्यन्ते प्राणप्रदवायोश्चाष्टौ । तदा हरिद्वायोः पञ्चत्रिंशद्भागाः प्राणप्रदस्य । ८ । ३२ । ५६ । एभिर्भागैः पृथक्संयुज्यन्ते । अथ । ८ । ३२ । ४० । । ५६ । एते ऽङ्का अष्टानामव्यवहितापवर्त्तनानि न भवन्ति । अव्यवहितापवर्त्तनाङ्कास्तु । ८ । १६ । २४ । ३२ । ४० । ४८ । ५६ । एते भवन्ति । अतः । १६ । २४ । ४८ । एते प्राणप्रदस्य भागा हरिद्वायुना संयुक्ताः केषुचित्पदार्थेषु वर्त्तेरन् ये पदार्था अस्माभिरद्यावधि न ज्ञायन्ते ॥

। २ । रसायनविधिना जायमानः संयोगो नियतपरिमा-

णयोरेव भवतीति नियमदर्शनात् भौतिकपदार्थानां सर्वेऽवयवा दिगादिवन्न विभागयोग्याः अपितु अत्यन्तसूक्ष्मा अशक्यविभागाश्च केचिदवयवास्सन्तीति कल्प्यते तेच परमाणव उच्यन्ते ॥

। ३ । किञ्च परमाणूनामतिसूक्ष्मत्वेऽपि तेषां सर्वथा महत्त्वराहित्यं न कल्प्यते तच्च चतुर्थोऽध्यायस्यारम्भे विस्तरेण निरूपितम् ॥

। ४ । अपिच यद्यपि सुवर्णादीनामेकजातीयाः परमाणवो गुरुत्वे महत्त्वेच परस्परं तुल्यरूपाः तथापि ते भिन्नजातीयलोहादिपरमाणुभ्यो गुरुत्वे विलक्षणा एव भवन्तीति ॥

। ५ । यदा रसायनविधिना संयुक्ताभ्यां पदार्थाभ्यामेकजातीयमेव कार्यमुत्पद्यते तदा तयोरेकस्यैकैकः परमाणुरपरस्यैकैकपरमाणुना संयुज्यते । यत्रच पदार्थयोर्मेलनाद्बहुजातीयकार्योत्पत्तिस्तत्रैकः परमाणुरेकेन द्वाभ्यां त्रिभिश्चतुर्भिर्वा संयुक्तो भवति ॥

। ६ । संयुज्यमानपदार्थपरिमाणस्य संख्यया तदीयपरमाणूनां परस्परापेक्षया गुरुलघुभावोऽनुमीयते । तद्यथा । एकमेकपलमितमपरञ्चाष्टपलमितमिति द्वे संयुक्ते यत्रैकं नवपलमितं कार्यं जनयतो यत्रच द्वयोः परमाणवः प्रत्येकमेकैकेन संयुज्यन्ते तत्रैकपलमितद्रव्यस्य परमाणुरष्टपलमितद्रव्यपरमाणोरपेक्षया ऽष्टगुणितगुरुरिति स्पष्टम् । यथा यदा विद्युद्वैषम्यकारकयन्त्रसम्बन्धिनोर्गुरुतमाख्यधातुसूत्रनिबद्धाग्रयोः स्वल्पान्तर-

योस्ताम्रसूत्रयोर्जलपात्रान्तः स्थापनेन जलमध्ये विद्युत्प्रवाह उत्पद्यते तदा जलव्यासे जाते प्राणप्रदो जलकरश्चेति द्वौ वायू प्रादुर्भवतः तयोः पृथक् पृथक् सङ्ग्रहे कृते नियमेन प्राणप्रदांशगौरवं जलकरांशगौरवादष्टगुणमुपलभ्यते अत एकस्य प्राणप्रदपरमाणोरेकेन जलकरपरमाणुना योगादेको जलपरमाणुरुत्पद्यत इति स्वीकारसम्भवाद् यथैकस्याष्टौ तथा जलकरपरमाणोः प्राणप्रदपरमाणुरिति सिद्ध्यति ॥

। ७ । एतस्यामिश्रद्रव्यपरमाणूनां परस्परापेक्षगुरुलघुभावस्य स्पष्टीकरणार्थं गुरुलघुभावसूचकैरङ्कैः सह तेषां नामानि लिख्यन्ते ॥

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| जलकरः १ | ज | ताम्रम् ३२ | ता |
| प्राणप्रदः ८ | प्रा | लोहम् २८ | लो |
| जीवात्मकः १४ | जी | सीसकम १०४ | सी |
| हरितः ३५ | ह | गुरुतमम् ९८ | गु |
| अङ्गारः ६ | अ | पारदः १०० | पा |
| टङ्ककरः ११ | ट | दस्तम् ३२ | द |
| गन्धकः १६ | ग | लघुतमम् ४० | लघु |
| अग्निप्रस्तरकरः २२ | अग् | लवणाकरम् २३ | ल |
| प्रकाशदः ३२ | प्र | चूर्णाकरम् २० | चू |
| सुवर्णम् ९८ | सु | अदाह्यपटकरम् १३ | अद |
| रजतम् ११० | र | स्फटीकरम् १४ | स्फ |

। ८ । बीजगणित इव रसायनकार्यविचारेऽपि तत्तद्द्रव्याणां सङ्क्षिप्तसङ्केतकरणमुपकारि यथा पूर्वसूच्यां प्रदर्शितम् ॥

। ९ । एते एव सङ्केता मिलितास्सन्तो मिश्रणफलस्य सङ्केता भवन्ति। यथा । ल इतिलवणाकरस्य त्रयोविंशतिषु भागेषु इतिच हरितस्य पञ्चत्रिंशत्सु भागेषु सङ्केतितम् तद्द्वयमपि ल+ह इतिरूपेण मिलितं सत् अष्टपञ्चाशद्भागान् लवणस्य बोधयति-इयं संख्या लवणपरमाणुगुरुत्वस्य संख्यां बोधयति । एवं सर्वत्र मिश्रणफले परमाणुगुरुत्वसङ्ख्यावगमप्रकारो बोध्यः ॥

। १० । अथैवमुक्तप्रकारेण मिश्रणफलसम्बन्धिनः सिद्धान्तानभिधायेदानीं प्राणप्रद्जीवान्तकवायुद्वयमिश्रणफलानि निर्णीयन्ते ॥

| | | |
|---|---|---|
| १ | जी+प्रा | २२ |
| २ | जी+२प्रा | ३० |
| ३ | जी+३प्रा | ३८ |
| ४ | जी+४प्रा | ४६ |
| ५ | जी+५प्रा | ५४ |

। ११ । एषु पञ्चस्वपि मिश्रणफलेषूक्तसङ्केतेन घटकद्रव्यपरमाणुपरिमाणं ज्ञाप्यते । घटकद्रव्यपरिमाणतज्जन्यत्वादिबोधकेनच सङ्केतेन रसायनशास्त्रे व्यवहार इष्टः । अत्रेदमधिकं विचार्यते । तथाहि । उक्तेषु प्राणप्रदजीवान्तकयोर्मिश्रणफलेषु

कानिचिदम्लरूपाणि कानिचित्तु न तथा । अथायमवश्यनि-रूपणीयो भेदः स्वबोधिकां संज्ञामपेक्षत इत्याह ॥

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अम्लानमम्लरूपताबोधकैस्सङ्केतैर्मिश्रणफलानां व्यव-हारः कर्त्तव्यः ॥ १३ ॥

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। १ । जीवान्तकप्राणप्रदमिश्रणफलेषु त्रीणि अनम्लरूपाणि अतस्तेषूत्तरोत्तरं केवलं प्राणप्रदपरिमाणाधिक्यबोधकसङ्केतेन व्यवहारः क्रियते यथा ॥

| | |
|---|---|
| जीवान्तकस्य | प्रथमप्राणप्रदजः । |
| जीवान्तकस्य | द्वितीयप्राणप्रदजः । |
| जीवान्तकस्य | परमप्राणप्रदजः । |

। २ । उक्तवायुद्वयमिश्रणफलेषु द्वे अम्लरूपे । तयोः सङ्केतायेदमारभ्यते । तथाहि । प्राणप्रदवायुना संयुक्तं द्रव्यं यदैकजातीयमम्लमारभते तदा सोऽम्लः ठञ्प्रत्ययान्तेन पदेन व्यवहर्त्तव्यः । यदा च उक्तद्रव्येण द्विजातीयौ अम्लौ उत्पाद्येते तदा तयोर्मध्येऽधिकप्राणप्रदविशिष्टो ऽम्लः ठञ्प्रत्ययान्तेन न्यून-प्राणप्रदविशिष्टो ऽम्लश्च यप्रत्ययान्तेन व्यवहर्त्तव्य इति तृतीयप-ञ्चमौ च पूर्वोक्तवायुमिश्रणफलभेदावम्लरूपौ क्रमेण न्यूनाधि-कप्राणप्रदविशिष्टौचातस्तयोर्जीवान्तक्यो जीवान्तकिकश्चेति सं-

ज्ञाद्वयं क्रमेण स्यात् । एवंच पञ्चानामपि वायुमिश्रणफला-
नामिमाः संज्ञाः ॥

॥ तथाहि ॥

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| । १ । | जीवान्तकस्य प्रथमप्राणप्रदजः ॥ |
| । २ । | जीवान्तकस्य द्वितीयप्राणप्रदजः ॥ |
| । ३ । | जीवान्तक्योऽम्लः ॥ |
| । ४ । | जीवान्तकस्य परमप्राणप्रदजः ॥ |
| । ५ । | जीवान्तकिको ऽम्ल इति ॥ |

। ३ । एवं जीवान्तकप्राणप्रदनामकस्य प्रथमतत्त्वद्वयस्य परस्परमिश्रणफलानि निरूप्य इदानीं जलकरसंज्ञकेन तृतीयेन तत्त्वेन सह उक्ततत्त्वद्वयस्य प्रत्येकं मिश्रणफलानि निरूप्यन्ते ॥

। ४ । जलकरः प्राणप्रदश्च प्रतिपरमाणु संयुक्तौ जलं जनयतः । अस्योपपत्तिर्वच्यते । अस्य मिश्रणफलस्य सङ्केतो ज+प्रा इति । पूर्ववत् जलपरमाणुगुरुत्वंच नवसङ्ख्याकं ज्ञेयम् ॥

। ५ । जलकरो जीवान्तकेन संयुक्तो नवसागरजनकं उग्रगंधं वायुविशेषं जनयति यः स्वभावतो ऽनुरागप्रेरित इव जलेन सह संयुज्य लीयते । अत्र जलकरस्य त्रयः परमाणव एकेन जीवान्तकवायुपरमाणुना सह संयुज्यन्ते अत उक्तवायोस्सङ्केतो ३ ज + जीइति तदीयपरमाणुगुरुत्वं च । १७ । सप्तदशसङ्ख्याकं बोध्यम् ॥

। ६ । हरितवायुनामकं चतुर्थं तत्त्वं प्राणप्रदजीवान्तकज-लकरवायुभिः संयुज्यमानं विविधानि मिश्रणफलानि जनयति । तत्र हरितजलकरवाय्वोः संयोगफलमिदानीं निरूप्यते तच्चो-ग्रगन्धं वायुस्वरूपं जलकरहरितकं अम्लं अनुरागप्रेरितमिव स्वभावतो जलेन संयुज्य लीयते । अस्य संक्षिप्तसंकेतश्च ज + ह इति एतदीयपरमाणुगुरुत्वंच ३६ षट्त्रिंशत्संख्याकं बोध्यम् ॥

। ७ । इदानीं क्रमप्राप्तानामवायुरूपाणाममिश्रद्रव्याणां मिश्रणफलानि निरूप्यन्ते ॥

। ८ । तत्र प्रथमोऽङ्गारः । अयं प्राणप्रदवायुना संयुक्तो-ऽङ्गारिकं अम्लं प्राणिप्राणहरं वायुविशेषमुत्पादयति । अयंच गुरुत्वाज्जलवत्पात्रात्पात्रान्तरे निर्गमयितुं शक्यते । अतएव यत्रायं क्वचिद्गिरिगुहाप्रदेशे स्वभावतो वर्त्तते तस्याधः प्रदेशे एव वर्त्तते नतूर्ध्वभागे तत्रच श्वादिः प्राणी अनुच्चत्वान्म्रियते मनुष्यादिजातिस्तूच्चत्वान्न प्राणं त्यजति । अस्याङ्गारिकाम्लस्य संक्षिप्तसंकेतो अं + प्रा इति एतदीयपरमाणुगुरुत्वं च २२ द्वाविंशतिसङ्ख्याकं भवति ॥

। ९ । प्राणप्रदवायौ ज्वलिताद्धीरादाङ्गारिकाम्लोत्पत्तेर्ही-रकोऽङ्गारारब्ध इति निश्चीयते ॥

। १० । अङ्गारो जीवान्तकवायुसंयुक्तो ज्वलनशक्तिमन्तं वि-चित्रगंधं जीवान्तकाङ्गारजाख्यं वायुविशेषं जनयति ॥

। ११ । अङ्गारो जलकरसंयुक्तो ज्वलनशक्तिमंतं जलकराङ्गारजाख्यं वायुविशेषं जनयति । अयंच क्वचित्तडागस्थपंकोत्सारणादुपलभ्यते । क्वचिच्च पञ्चनददेशीयज्वालामुखीप्रदेशादौ अयमेव भूविवरात्सदा ज्वलन् महापरिमाणो निर्याति । एतज्जातीय एव वायुविशेषः प्रस्तराङ्गारेभ्यो निष्कृष्टुं शक्यते एषु दिवसेषु यूरोपप्रदेशे रात्रौ रथ्याप्रकाशनाय प्रयुज्यतेचेति ॥

। १२ । गंधकं प्राणप्रदवायोस्त्रिभिः परमाणुभिः संसृष्टं गांधकिकमम्लं वायुरूपं जले लययोग्यं उत्पादयति । तस्य संकेतो गं + ३ प्रा इति परिमाणुपरिमाणञ्च ४० चत्वारिंशत्संख्याकं बोध्यमिति ॥

। १३ । प्रकाशदः प्राणप्रदस्य पञ्चभिः परमाणुभिः संयोगे सति प्राकाशदिकमम्लं जनयति । तस्य सङ्केतः प्र + ५ प्रा इति अतस्तदीयपरमाणुगुरुत्वं द्विसप्ततिसङ्ख्याकं ज्ञेयम् ॥

। १४ । प्रकाशदो जलकरसंयुक्तः साधारणवायौ स्वतो ज्वलनस्वभावं वायुविशेषं जनयति । अयञ्च प्रकाशदस्य जलकरज इति व्यवह्रियते ॥

। १५ । अमिश्रद्रव्याणि धात्वधातुभेदेन द्वेधा विभक्तानि । तत्र वाय्ववायुभेदेन द्विविधानामधातुद्रव्याणां मिश्रणफलानि निरूपितानि । इदानीं धातूनां स्वभेदैः सह उक्तद्रव्यैश्च सह मिश्रणफलानि निरूप्यन्ते ॥

। १६ । लोहादिनानाधातूनां प्राणप्रदेन सह मिश्रणफलं

किट्टमिति लोके व्यवह्रियते । सुवर्णं रजतञ्च प्राणप्रदेन संयोगं नेच्छतीव अतएव सुवर्णरजते व्यावहारिकमुद्रादिरचनाय सम्यगुपयुज्येते ॥

। १७ । लोकप्रसिद्धरक्तिम लोहकिट्टं द्वाभ्यां लोहपरमाणुभ्यां त्रिभिश्च प्राणप्रदपरमाणुभिरारब्धं भवति । यदि द्वयोस्त्रयस्तर्ह्येकस्य सार्द्धमिति प्रमाणानुसारेण उक्तलोहकिट्टं लोहस्य सार्द्धप्राणप्रदजमित्युच्यते अस्य सङ्केतो २ लो + ३ प्रा इति । अतएव तत्परमाणुगुरुत्वं चत्वारिंशन्मितंभवतीति । अथ प्राणप्रदलोहयोरन्यदेकं मिश्रणफलं लोहस्य प्रथमप्राणप्रदजमित्युच्यते यत्रैको लोहपरमाणुरेकेन प्राणप्रदपरमाणुना संयुज्यते अतस्तस्य सङ्केतो लो + प्रा इति अतश्चास्य परमाणुगुरुत्वं षट्त्रिंशन्मितं बोध्यम् । इदञ्च तप्तायोगोलाभिघातोत्पतितश्यामलोहमलांशस्वरूपम्भवति ॥

। १८ । सीसकस्य प्रथमप्राणप्रदजं पीतं भवति द्वितीयप्राणप्रदजं च रक्तं सिन्दूरमिति लोके प्रसिद्धं भवतीति ॥

। १९ । पारदस्य परमप्राणप्रदजं रक्तवर्णं भवति । पारदहरितवाय्वोः संयोगाद्द्वे मिश्रणफले भवतः तत्र प्रथमहरितपारदजः श्वेतवर्णश्चूर्णविशेषो महौषधं परमहरितपारदजं रसकर्पूर इतिलोकप्रसिद्धं महाविषं ॥

। २० । पारदधातुर्द्रवरूपः श्वेतवर्णो गन्धकसंयोगादत्य-

न्तरक्तवर्णं हिङ्गुलं जनयतीति अष्टमसूत्रव्याख्यावसाने उक्तं। अत्र शास्त्रे तत् पारदस्य द्वितीयगन्धकजमित्युच्यते ॥

। २१ । पारदोऽनेकैर्धातुभिः सह शीतावस्थायामपि संयुज्यते । रजतपात्राणां सुवर्णलेपसिद्धये सुवर्णमिश्रितः पारद उपकरोति ॥

। २२ । लघुतमं प्राणप्रदसंयोगेन शुक्लवर्णं अतितीक्ष्णरसं द्रव्यविशेषं जनयति इदंच मांसं कर्तयति अस्य संज्ञा लघुतमा इति भवति ॥

। २३ । लवणाकरप्राणप्रदसंयोगफलं लघुतमप्राणप्रदसंयोगेनात्यन्तसदृशं अस्ति ॥

। २४ । हरितवायुना सह लवणाकरमेलनात्साधारणलवणमुत्पद्यते । अत्र शास्त्रे तस्य नाम लवणाकरस्य हरितज इति । अस्य सङ्केतो ल+ह इति अतोऽस्य परमाणुगुरुत्वं अष्टपञ्चाशन्मितं भवति ॥

। २५ । चूर्णकरप्राणप्रदसंयोगात् लोकप्रसिद्धं गृहनिर्माणोपयोगि चूर्णमुत्पद्यते ॥

। २६ । एतावता द्रव्यद्वयारब्धमिश्रणफलानि निर्णीय तदधिकद्रव्यमिश्रणफलानि अधुना निरूप्यन्ते । त्रयोदशसूत्रेऽम्लानम्लरूपविभागद्वयस्य तदीयाम्लत्वाऽनम्लत्वबोधकसंज्ञया व्यवहारः कर्त्तव्य इत्युक्तम् । अम्ल इति संज्ञया अम्लानामम्लरसवत्स्वरूप एको विशेषधर्मो बोध्यते अन्यश्चाम्लानां वि-

शेषधर्मोऽयं भवति यत्तेषां कुसुमजपादिपुष्परससंयोगजनितनी-लिम्ना जलेन संयोगे तज्जलस्य रक्तताऽऽपादनमिति। कानिचि-दनम्लानि द्रव्यद्वितयमात्रसंयोगफलानि लघुतमावदातितीव्र-रसानि सन्ति तानिचोक्तविधजलस्य स्वसंयोगेन हरिततां जन-यन्ति । एवंविधैरम्लविपरीतैरन्यैश्च धातुप्राणप्रदसंयोगफलैः किट्टैस्संयुक्तान्यम्लानि बहुविधमिश्रणफलजनकानि भवति त-न्निरूपणाय सूत्रम् ॥

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अम्लानां धातुप्राणप्रदसंयोगफलैः किट्टैः संयो-गाल्लवणविशेषा जायन्ते ॥ १४ ॥

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।१। खाद्यलवणसादृश्याल्लवणशब्दोऽत्र लाक्षणिकः । लवणविशेषा इति न सर्वा लवणजातिरम्लधातुप्राणप्रदसंयो-गफलभूतकिट्टमिश्रणजन्या ऽपितु कतिपयलवणजातिरेव यतः खाद्यलवणं हरितलवणकरमिश्रणजन्यं भवति इदञ्च पूर्वमुक्तं । अथैते लवणविशेषा उच्यन्ते ॥

।२। केचिदम्ला इगन्तेन केचिच्च यान्तेन पदेन व्यवह-र्तव्या इत्युक्तं । तत्रेगन्तपदव्यवहृताम्लजनितलवणजातिर्यद-न्तेन यान्तपदव्यवहृताम्लजनितलवणजातिश्चेदन्तेन पदेन व्य-वहर्त्तव्या । यथा । जीवान्तकिकाम्लजं लवणं जीवान्तकायि-तमिति यथाच जीवान्तक्याम्लजं लवणं जीवान्तकितमिति ॥

। ३ । अकम्लानि किट्टैरेव संयुज्यन्तेन धातुमात्रेणेतिनियम-दर्शनादनेकजातीयकिट्टाम्लमिश्रणजनितातिरिक्तानां लवणानां किट्टजन्यताबोधकपदेन व्यवहारोऽनावश्यकः । अतश्च रजत-प्राणप्रदजस्य जीवान्तकायितमितिसंज्ञापेक्षया लाघवाद्रजतस्य जीवान्तकायितमित्येव संज्ञा कर्त्तव्या । परन्तु लोहप्रथमप्राण-प्रदजस्य गन्धकायिते लोहसार्द्धप्राणप्रदजस्य गन्धकायितेच पर-स्परभेदज्ञापनाय तत्तत्किट्टजन्यताबोधकसंज्ञया व्यवहारः कर्त्तव्य इति ॥

। ४ । वक्ष्यमाणायां भागद्वयवत्यां सूच्यां वामभागे अम्लाः किट्टानि तेषां संक्षिप्तसङ्केताः परमाणुगुरुत्वञ्च निहितं दक्षि-णभागे फलभूतानि लवणानि फलभूताः संक्षिप्तसङ्केताः पर-माणुगुरुत्वञ्च निहितमस्ति यथा ॥

लघुतमाया जीवान्तकायितम्

| | |
|---|---|
| जीवान्तकिकाम्ल=जी+५प्रा=५४ ।<br>लघुतमा=ल+प्रा=४८ । | लघुतमाया जीवान्तकायितम्<br>=लप्रा+जी५प्रा=१०२ ॥ |

अयं लवणविशेषो ऽग्निशस्त्रप्रयोगोपयुक्तचूर्णनिर्माणोपयो-गित्वेन लोके प्रसिद्धः ॥

अथ नवसागरकरस्य जीवान्तकायितम्

| | |
|---|---|
| जीवान्तकिकाम्लम्=५४<br>नवसागरकर:=३ज+जी<br>=१७। | नवसागरकरस्य जीवान्तकायि-<br>तम्=७१॥ |

अयं लवणविशेषो जीवान्तकस्य प्रथमप्राणप्रदजनामकं उन्मादकं पूर्वोक्तं वायुविशेषं जनयति॥

अथ रजतस्य जीवान्तकायितम्

| | |
|---|---|
| जीवान्तकिकाम्लम्=५४। रजतस्य<br>प्राणप्रदजम्=११०+८=११८ | रजतस्य जीवान्तका-<br>यितम्=१७२॥ |

अयं लवणविशेषश्चिकित्सकैर्व्रणोत्पन्नदुर्मांसविनाशाय प्रयुज्यते॥

अथ लवणकराया गन्धकायितम्

| | |
|---|---|
| गान्धकिकाम्लम्=ग+३प्रा=४०।<br>लवणकरा=लव+प्रा=३१ | लवणकराया गन्ध-<br>कायितम्=७१॥ |

अयं लवणविशेषो विद्युद्यन्त्रनिर्माणे उपयुज्यते॥

अथ चूर्णस्य गन्धकायितम्

| | |
|---|---|
| गान्धकिकाम्लम्=४०।<br>चर्णम्=चू+प्रा=२८ | चूर्णस्य गन्धकायितम्=६८॥ |

अयं लवणविशेष: कठिनीवत् शुक्लवर्णो भवति प्रतिमाविशेषनिर्माणे उपयुज्यते॥

अथ ताम्रस्य गन्धकायितम्

| | |
|---|---|
| गान्धकिकाम्लम्=४० ।<br>ताम्रस्य प्राणप्रदजम्<br>=ता+प्रा=४० | ताम्रस्य गन्धकायितम्=८० |

अयं नीलवर्णो लवणविशेषो विद्युद्यन्त्रनिर्माणे उपयुज्यते ॥

अथ लोहप्रथमप्राणप्रदजस्य गन्धकायितम्

| | |
|---|---|
| गान्धकिकाम्लम्=४० ।<br>लोहप्रथमप्राणप्रदजम्<br>=लो+प्रा=३६ | लोहप्रथमप्राणप्रदजस्य गन्धकायितम्=७६ ॥ |

अयं हरिद्वर्णो लवणविशेषः लोके कासीस इति प्रसिद्धः ॥

अथ नवसागरकरस्य जलकरहरितायितम्

| | |
|---|---|
| जलकरहरिताम्लम्=३६ ।<br>नवसागरकरः=१७ ॥ | नवसागरकरस्य जलकरहरितायितम्=५३ ॥ |

अयं लवणविशेषो नवसागरइति प्रसिद्धो जल शीतीकरणादावुपयुक्तः ॥

अथ चूर्णस्याङ्गारायितम्

| | |
|---|---|
| आङ्गारिकाम्लम्=अं+२प्रा=२२ ।<br>चूर्णम्=२८ ॥ | चूर्णस्याङ्गारायितम्=५० ॥ |

अयं लवणविशेषो लोके कटिनीति प्रसिद्धः ॥

अथ लवणकरायाष्टङ्करायितम्

टङ्करिकाम्लम्=ट+६प्रा=६८ । } लवणाकरायाष्टङ्करा
लवणाकरा=३१ } यितम्=९९ ॥

अयं लवणविशेषष्टङ्क इति प्रसिद्धः ॥

अथ चूर्णस्य प्रकाशदायितम्

प्राकाशदिकाम्लम्=प्र+५ प्रा=७२ । } चूर्णस्य प्रकाशदा-
चूर्णम्=२८ } यितम्=१०० ॥

अयं लवणविशेषो मुख्यो मनुष्याद्यस्थ्यारम्भकोऽस्ति ॥

। ५ । एवमुक्तप्रकारेण पूर्वोक्ततत्त्वानामप्रसिद्धान्यापामरप्रसिद्धानिच मिश्रणफलानि निरूपितानि तत्रचानेकद्रव्ययोगादेकद्रव्योत्पत्तिर्वर्णिता । तदर्थं क्रियमाणोऽनेकद्रव्यसंयोगः समासकरणमित्युच्यते । यत्रच कस्यचिदवयविन आरम्भकद्रव्यजातिनिर्णयाय तदीयावयवानां विभागः क्रियते तत्र स विभागः समासकरणविपरीतत्वाद्व्यासकरणमित्युच्यते । तस्योपायं निरूपयितुमाह ॥

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रसायनशास्त्रोक्तानां मिश्रणफलानामवयवविभागे
त्रयो हेतवः औष्ण्यं विद्युत् व्यास्यद्रव्यारम्भका-
वयवगतपरस्पराकर्षणशक्त्यधिकतत्तदन्यतराकर्ष-
णशक्तिमत्पदार्थसान्निध्यञ्चेति ॥ १५ ॥

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। १ । तत्रौष्ण्यं यथा पूर्वोक्तं रक्तवर्णं पारदस्य प्राणप्रदजं

अग्नितापेन विलीयामिश्रपारदरूपेणामिश्रप्राणप्रदवायुरूपेणाच व्यस्तं भवति प्राणप्रदवायोरमिश्रस्वरूपप्राप्त्यर्थमयमेक उपायोऽस्ति ॥

। २ । विद्युद्यथा विद्युत्संयोगेन जलममिश्रजलकरवायुरूपेण शुद्धप्राणप्रदवायुरूपेण च व्यस्तं भवति ॥

। ३ । व्यास्यद्रव्येत्यादि । यथा । पूर्वोक्तं तुत्थाख्यं ताम्रस्य गन्धकायितं स्वमिश्रितजले स्वच्छलोहखण्डप्रक्षेपेण व्यसितुं शक्यते । तथाहि । एतावस्थायां ताम्रमपेक्ष्य लोहस्याम्लाकर्षणशक्त्याधिक्यादम्लं लोहेन संयुज्यते ताम्रञ्चाम्लेन वियुक्तं स लोहपृष्ठमेवाधिरोहति । सकले ताम्रे लोहपत्राधिरूढे लोहांशेषु चाम्लमिश्रितेषु जातेषु तत्र जले काशीशाख्यं लोहस्य गन्धकायितमुपलभ्यते न तु ताम्रस्येति ॥

। ४ । रसायनज्ञैः प्रतिपदार्थं यावन्त आकर्षकाः पदार्थाः प्रत्यक्षपरीक्षणैर्ज्ञायन्ते त एकस्मिंश्चक्रे लिख्यन्ते । तेषु योऽधिकाकर्षकः स आदौ ततो न्यूनाकर्षक इति क्रमो भवति । एतच्चक्रस्यावलोकनेन यस्मिन् कस्मिंश्चित्पदार्थे तद्व्यासकरणार्थं ये ये पदार्थाः प्रक्षेप्यास्ते ज्ञायन्ते ॥

। ५ । पूर्वलिखितायां सूच्यां प्रदर्शितानांद्रव्याणां परमाणुगुरुत्वसङ्ख्या तत्तत्तुल्यबलाङ्कशब्देनापि व्यवह्रियते यतस्ते मिश्रपदार्थोत्पादने स्वस्वाङ्कपरिमितास्तुल्यबला भवन्ति । यत्र यः पदार्थः स्वाङ्कपरिमितो वर्त्तते तत्रान्योऽपि स्वाङ्कपरिमाणेनैव

स्यातुं शक्नोतीत्यर्थः । यथा । पूर्वोदाहृतौ तुल्यस्य व्यासकरणेन चेदेकत्रिंशन्माषमितं ताम्रं पृथग्भवेत्तदा तत्र सप्तविंशतिमाषमितं लोहं संयुज्येत यावत्यम्लरसे एकत्रिंशन्माषमितं ताम्रं लीयते तावति सप्तविंशतिमाषमितमेव लोहं विलीयते नत्वधिकमित्यर्थः । एवं परीक्षणेन ताम्रलोहयोस्तुल्यबले क्रमेणैकत्रिंशत्सप्तविंशत्यंशप्रमाणे भवतः । इत्थं प्रत्यक्षपरीक्षयैव चक्रेऽङ्का लिखिताः । यस्य कस्य कस्यापि पदार्थस्य व्यासकरणार्थं निर्मित्यर्थं वा तद्घटनावयवा यावत्प्रमाणा उपयुज्यन्ते तत्प्रमाणानि चक्राङ्कालोकनेन निःशङ्कं ज्ञायन्ते रसायनज्ञैः ॥

। ६ । ताम्रगन्धकायितस्य लोहसंयोगाद् यो विकारो व्यासकरणफलभूतः पूर्वमुक्तः स सङ्क्षिप्तसङ्केतोपायेन प्रकाश्यते । यथा ॥

ताम्रस्य किट्टम् { ता=३२ —————— ताम्रम्=३२
{ प्रा=८

ग+३प्रा=४०

लो=२८ —— लोहस्य

गन्धकायितम्=ग३प्रा+लप्रा=७६ ॥

। ७ । लवणजातिषु सर्वे धातवः किट्टरूपेणैव तिष्ठन्तीत्युक्तं । इदंत्ववधातव्यम् यद्रसायनीयपदार्थानां दर्शिततुल्यबलं लाङ्कानुसारेण यावानेव ताम्रसम्बन्धी प्राणप्रदो द्वात्रिंशन्मितं ताम्रं ताम्रगन्धकायिते किट्टतानां यति तवानेवाष्टाविंशतिमितं

कारब्धप्रसिद्धप्रस्तर इत्युक्तः खनिजः स्फटीजनिकाया अग्निप्रस्तरायिताख्यलवणस्य लघुतमाया अग्निप्रस्तरायिताख्यलवणस्य चान्योन्यमिश्रणादुत्पद्यते । स च क्वचित् पाटलवर्णेषु नियताकारेषु लभ्यते । स्थितिस्थापकविशिष्टमभ्रकं प्रायेणाद्राह्वपटजनिकया मिश्रिताभ्यामग्निप्रस्तरस्फटीजनिकाभ्यां जनितमस्ति तत् प्रायेण मृदु सूक्ष्मपत्रोच्चयरूपं मौक्तिकप्रभमुपलभ्यते । प्रथमकाठिन्यपदस्थादभ्रकादस्य स्थितिस्थापकत्वेन भेदः । खनिजेषु वालुकोच्चयजन्यः प्रस्तरविशेषो विद्यते यस्य त्रिलक्षणायां स्वैरनम्यतायामिदमेवाभ्रकं हेतुरिति ॥

। १७ । अथ शुद्धखनिजमिश्रणफलभूतानां मिश्रखनिजानां मध्ये केचन महोपयोगाः खनिजा निरूपणीयास्तदर्थं प्रतिजानीते ॥

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मिश्रखनिजाः कणोच्चयसन्निभनामकादयो
भवन्ति ॥ २० ॥

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। १ । तत्र कणोच्चयसन्निभनामकः खनिजः प्रसिद्धस्फाटकस्य स्थितिस्थापकविशिष्टाभ्रकस्य स्फटीजनकारब्धप्रसिद्धप्रस्तरस्य चान्योन्यमिश्रणफलभूतोऽस्ति । अस्मिन् वर्तमानाः प्रसिद्धस्फटिकस्य स्फटीजनकारब्धप्रसिद्धप्रस्तरस्य च कणमयाः स्तराः स्थितिस्थापकविशिष्टाभ्रकपत्रैर्व्यवहिताः सन्ति ॥

। २ । अभ्रकीयप्रस्तरफलकः स्वस्मिन् पृथग्भावेनाव स्थितस्य स्थितिस्थापकविशिष्टाभ्रकस्य प्रसिद्धस्फटिकस्य च मिश्रणफलभूतोऽस्ति ॥

। ३ । पङ्कमयप्रस्तरफलकः स्थितिस्थापकवदभ्रकस्य प्रसिद्धस्फटिकस्य स्फटीजनकारब्धप्रस्तरस्य स्थितिस्थापकरहिताभ्रकस्य चेत्यादीनामपृथग्भावदृश्यैः कणैरारब्ध इति । तस्य च वर्ण ईषद्धरितश्वेतकृष्णादिः ॥

। ४ । कणोच्चयनामकस्य कणोच्चयसन्निभनामकस्य चारम्भकाः समाना एव केवलं तु कणोच्चयनाम्नि खनिजे स्थितिस्थापकविशिष्टमभ्रकं समानान्तरपतरूपेण न तिष्ठत्यतस्तस्याकारः प्रस्तरफलकवन्न दृश्यते किन्तु कणोच्चयवदिति ॥

। ५ । कृष्णप्रस्तरनामकः खनिजो ऽग्न्यतिथिना स्फटीजनकारब्धप्रसिद्धप्रस्तरेण चेति द्वाभ्यामपृथग्भावदृश्यावस्थाभ्यां जनितो ऽस्ति ॥

। ६ । ज्वालामुखीप्रस्तरनामकः खनिजो ऽग्न्यतिथिनामकादिमं विशेषं बिभर्ति यदस्य काठिन्यमग्न्यतिथेः काठिन्यान्न्यूनमिति ॥

। ७ । वालुकाप्रस्तरनामकः खनिजः पङ्कलेशादिना ऽऽश्लेषसाधनेनाश्लिष्टैः प्रसिद्धस्फटिकस्याणुभिरारब्धो ऽस्ति ॥

। ८ । पङ्क इति प्रसिद्धः खनिजः स्फटीजनिकायाश्चूर्ण-

नाग्निप्रस्तरेण च मिश्रणाज्जायते स च जलयोगेन मृदुतामासादयन् विविधाकारपरिणामयोग्यो भवत्यतः कुलालादीनामुपकाराय भवति ॥

। ९ । भूगोलपुटानां मध्ये यदुपरितनं स्तराकारं पुटं यत्र कृषिः सफला भवति तन्मृत्स्नापदेनोच्यते तच्च प्राणिवृक्षशरीरांशानां विविधशिलासमूहघर्षणोत्पन्नधूलीनां चान्योन्यमिश्रणादुत्पद्यत इत्यलं विस्तरेण ॥

। १० । रसायन प्रकरणे व्यासकरणोत्तरं मानुषशक्तिसाध्यपुनरुत्पत्तयः पदार्था वर्णिताः । यथा । पारदस्य प्राणप्रदजः प्राणप्रदरूपेण पारदरूपेणच यथा व्यस्तः कर्तुं शक्यः तथा पुनरपि प्राणप्रदपारदयोर्मेलनात्पूर्ववत् कर्तुं शक्य इति । कश्चित्पुनः पदार्था नैतादृशस्वभावाः । यथा । काष्ठखण्डं व्यासकरणोपायैः प्राणप्रदजलकरशुद्धाङ्गारस्वरूपतां नेतुं शक्यते मांसखण्डं वा प्राणप्रदजलकरजीवान्तकशुद्धाङ्गारस्वरूपतां न पुनः कयाचिदस्मद्युक्त्या पूर्वरूपमिति यत एषां पुनरुत्पादने जीवनशक्तिरसाधारणं कारणं नच सा मानुषशक्तिसाध्येति । सा च स्थावरेषु जङ्गमेषु च वर्तते ॥

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जीवनशक्ती रसायनविधीन् प्रतिबध्नात्यन्यथाकरोति वा ॥ २१ ॥

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। १ । भूमौ निक्षिप्तं बीजं मनुष्यशक्यसाध्यान् गुणान् वृक्षे जनयति । यथा । मञ्जिष्ठाबीजं लोकोत्तरं वर्णमाम्रबीजं वा लोकोत्तरं रसमुत्पादयति ॥ .

। २ । तत्र स्थावरशरीरस्वरूपमभिधातुं बीजाद् वृक्षो-त्पत्तिप्रकारमाह ॥

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भूमिनिहितं बीजं स्वस्वजातीयाङ्कुरोत्पादानुकूले काले ऊर्ध्वाधोगामिनौ द्वावङ्कुरौ जनयति तत्रो-र्ध्वगामिना प्रकाण्डो ऽधोगामिनाच मूलमार-भ्यते ॥ २२ ॥

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। १ । भूमध्यान्निर्गच्छन्नवाङ्कुरस्तेजसे स्पृहयतीव यतस्ते-जस्संयोगाभावे हरितवर्णरहितपल्लवतां प्राप्ता वृक्षजातिर्म्लायते । यथैव दिशा यावतैवावकाशेन तेजस्तत्सन्निधिं प्राप्नोति तामेव दिशं तावतैवावकाशेन वृक्षजातिरपि तेजोऽभिमुखं याति ॥

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वृक्षाः स्वशरीरपुष्टिहेतून् पदार्थान् मूलेन पृथ्वी-तः पत्रैश्च वायोः सकाशादाकृष्य गृह्णन्ति ॥ २३ ॥

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। १ । प्राणप्रदजलकराङ्गारा वृक्षजातेस्साधारणारम्भका इति पूर्वं सूचितम् । तत्र वृक्षवृद्धिविषये जलसेकस्यात्यावश्यक-त्वेन वृक्षैस्स्वमूलाकृष्टजलात्प्राणप्रदजलकरौ प्राप्येते ॥

। २ । अङ्गारस्तु वायोः सकाशात्प्राप्यते यतोऽङ्गारः प्राण-प्रदमिलितोऽङ्गारिकाम्लवायुविशेषस्वरूपेण साधारणवायौ तिष्ठति सच वायुविशेष उच्छ्वासक्रियया काष्ठादिदहनक्रियया चोत्पद्यते ॥

। ३ । प्रत्यक्षञ्चात्र प्रमाणम् । तथाहि । काचपात्रान्तर्वर्त्तिनि स्वच्छजलसदृशे चूर्णजले काचनलिकाद्वारा श्वासवायुः प्रवेश्यतां येन श्वासक्रियाजन्याङ्गारिकाम्लवायुसंयोगवशात्तज्जलान्तर्गतचूर्णे काठिन्यवस्थामागच्छति सति तज्जलं कठिनीमयत्वात् क्षीरवर्णं भविष्यतीति ॥

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जन्तूनामुदरफुप्फुसे यत्कार्यं सम्पादयतस्तदेव
कार्यं वृक्षाणां पत्राणि सम्पादयन्ति ॥ २४ ॥

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। १ । यथा जन्तूनामुदरं भुक्तान्नसम्बन्धिनां शरीररक्षासम्पादकानामंशानां अन्तस्सङ्ग्रहेणानुपयुक्तानामंशानां बहिर्निःसारणेनचोपकारकं भवति तथैव वृक्षाणां पत्राण्युक्तकार्यसम्पादनेनोपकुर्वन्ति। वृक्षाणां स्तम्बशाखाद्युत्पादनायाङ्गार आवश्यकः सच पर्णैराङ्गारिकाम्लवायुसकाशाद्गृह्यते तत्सम्बन्धिप्राणप्रदश्च त्यज्यते ॥

। २ । तदेवं जन्तवस्स्वसजातीयापकारकं वृक्षाणामत्युपकारकं वायं निःश्वसन्ति वृक्षा अपि जन्तुनिःश्वसितं स्वोपका-

रकं वायुमन्तरादाय जन्तूपकारकं प्राणप्रदवायुं बहिर्निःसारयन्तीतिसिद्धम् ॥

। ३ । अङ्गारिकाम्लवायुर्जन्तुभिर्निःश्वस्यत इत्यत्र पूर्वं युक्तिर्दर्शिता इदानीं प्राणप्रदो वृक्षैर्निःश्वस्यत इत्यत्र प्रमाणम् प्रदर्श्यते ॥

। ४ । तथाहि । अम्लानपत्रसहितं जलपूर्णं विशालकाचपात्रं जलपूर्णे पात्रान्तरेऽधोमुखं संस्थाप्यातपे स्थाप्यतां ततः पत्रेभ्यः प्राणप्रदवायुर्निर्गमिष्यति तन्निर्गमनलक्षणानिच पूर्वोक्तरसायनप्रकरणप्रतिपादितविद्यानुसारेणावगन्तव्यानीति ॥

। ५ । पुष्पाणां केसरा द्विविधा भवन्ति पौरुषाः स्त्रैणाश्चेति । येषामग्रेषु पुष्परजो वर्त्तते ते पौरुषा अन्ये स्त्रैणा भवन्ति ॥

। ६ । अथ यदा पौरुषकेसररजांसि स्त्रैणकेसरे पतन्ति तदा बीजमुत्पद्यते नत्वन्यथा । अतो यदि कस्यचित्पुष्पस्य पौरुषकेसरा निष्कास्येरंस्तदा तस्मात्फलं नोत्पत्स्यते । यदि तु कस्यचिद्वृक्षस्य पुष्पात्पौरुषकेसरानपास्य तत्स्त्रैणकेसरे तत्सजातीयान्यवृक्षपुष्पपौरुषकेसरस्य रजः क्षिप्यते तदा तस्मात् तद्वृक्षद्वयगुणविशिष्टं बीजमुत्पद्यते । एवं यत्नेनानेके पुष्पविशेषा उत्पाद्यन्ते ॥

। ७ । अथ कस्मिंश्चित्सजातीयवृक्षवर्गे कतिषुचिद्वृक्षेषु पौरुषकसरविशिष्टान्येव पुष्पाणि भवन्ति ते पुरुषाख्याः स्युः । अन्यषुच वृक्षेषु स्त्रैणकेसरविशिष्टान्येव पुष्पाणि भवन्ति ते स्त्री-

संज्ञकाः स्युः । तत्र पुरुषाख्या नैव फलन्ति अतएव ते बन्ध्या उच्यन्ते । तेषां बन्ध्यत्वे स्त्रैणकेसराभावः कारणम्भवति । स्त्री-संज्ञकाश्च पुरुषनिकटस्थाः पौरुषकेसररजःसंयोगेन फलन्ति यथा खर्जूरादयः ॥

। ८ । अथ स्थावरशरीरस्वरूपनिरूपणाङ्गभूतं वृक्षजातिभेदं प्रदर्शयति ॥

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वानस्पत्या वनस्पतयश्चेति द्विविधा वृक्षा भवन्ति ॥ २५ ॥

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। १ । तत्र वनस्पतयोऽपुष्पवन्त उदुम्बरादयः । पुष्पवन्तो वानस्पत्या आम्रादयः ॥

। २ । पिप्पलादयो वृक्षा अपुष्पवद्गणे न गण्यन्ते यतस्तेषां पुष्पाणि फलान्तर्भागे सूक्ष्मदर्शकयन्त्रद्वारा दृश्यानि भवन्ति ॥

। ३ । वानस्पत्येषु समानपौरुषकेसराणां पृथग्वर्गाः क्रियन्ते तेषु च प्रत्येकं समानस्त्रैणकेसराणां पृथग्वर्गाः क्रियन्ते पत्राद्याकारादिभिस्तेषां विशेषा निर्णीयन्ते ॥

। ४ । वृक्षाणां जीवनशक्तिमत्त्वेऽपि देशान्तरगमनानुकूलप्रयत्नरहितत्वादेव जङ्गमजीवेभ्यो भेदः ॥

। ५ । अथ जङ्गमशरीराणां विचारः कर्तव्यस्तत्रादौ मनुष्यशरीरसंस्थानमाह ॥

अस्थिपञ्जरो मांसरज्जुर्मस्तिष्कमुदरं हृदयं फुप्फु-
सं रक्तवहा नाड्य इत्यवयवा मनुष्यशरीरस्य ॥ २६ ॥

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। १ । तत्र चतुःपञ्चाशदधिकद्विशतसङ्ख्यकास्थिसङ्घातोऽस्थिपञ्जरः ॥

। २ । मांसस्य मुख्योंऽशो मांसरज्जुः । अस्या आकुञ्चनप्रसारणे इच्छाजनितयत्नेन भवतः ताभ्याञ्चास्थिपञ्जरवर्तीन्यस्थीनि चाल्यन्ते ॥

। ३ । विशेषतः शिरसि वर्तमानः शुक्लवर्णः स्नेहविशेषो मस्तिष्कं । सूक्ष्मतन्त्वाकारा अस्यांशाः पृष्ठवंशद्वारा प्रसरन्तो नखकेशान्विहाय सर्वान् शरीरावयवान् व्याप्नुवन्ति । अतएव नखकेशावच्छेदेनैच्छिकी क्रिया ज्ञानञ्च नत्पद्यते ॥

। ४ । शरीरपुष्ट्युपयुक्ता ुपयुक्तावन्नांशौ येन विभाज्येते तदुदरम् ॥

। ५ । जीर्णमन्नं सर्वावयवपुष्ट्युत्पादकरुधिरवर्द्धकशुक्लरसस्वरूपेण परिणतं नालद्वारा यत्र प्रविशति तद् हृदयं ॥

। ६ । सन्तताकुञ्चनप्रसारणवतो हृदयस्थलान्निर्गत्य यत्र रुधिरं प्रथमं प्राप्नोति तत्फुप्फुसम् । हृदयनिर्गतं रुधिरं यद्वारा फुप्फुसं प्रविशति पुनश्च सर्वशरीरे कृतसञ्चारं यद्वारा हृदयं प्राप्नोति ता नाड्यो रक्तवहा इत्युच्यन्ते ॥

। ७ । फुप्फुसदेशे रुधिरं प्राणप्रदवायुना संयुज्यते अङ्गा-

लोहं किट्टतां प्रापयति परन्तु जलमिश्रितगान्धकिकाम्ले प्रक्षिप्तं लोहं तदम्लेन स्वस्य रसायनीयसंयोगसिद्धये यथोपयोगं जलात्प्राणप्रदमाकृष्य गृह्णाति। अत एकाकी जलकरो बुद्बुदद्वारा निर्याति इदञ्चानन्तरालेख्ये स्पष्टं यथा ॥

जलम् { जलकरवायुः —————————— जलकरवायुः
{ प्राणप्रदवायुः
गान्धकिकाम्लम्
लोहम् —————— लोहस्य गन्धकायितम् ॥

। ८ । द्रव्यत्रयविषयेषूक्तोदाहरणेषु सर्वत्रैकं द्रव्यमपरद्रव्यमाकृष्य तृतीयमुत्सारयतीति समानं क्वचित्तु भिन्नभिन्नद्रव्यचतुष्टयारब्धे द्वे मिश्रणफले परस्परसंयोगदशायां स्वघटकावयवादानप्रतिदाने कुरुतः । यथा चूर्णस्य जलकरहरितापयितं यदा जलमिश्रितं सत् तथाविधेन नवसागरकरस्य गन्धकायितेन संयुज्यते तदा गान्धकिकाम्लं चूर्णेन संयुज्यते जलकरहरितिकाम्लं च गान्धकिकाम्लवियुक्तेन नवसागराख्यजनकेन संयुज्यते । यदा च चूर्णस्य जलकरहरितायितं केवलेन गान्धकिकाम्लेन संयुज्यते तदा तत् तत्र स्वसंयोगयोग्यद्रव्यान्तरानुपलम्भाद्वायुरूपेण बहिर्निर्याति । तदिदमालेख्येन प्रदर्श्यते । तत्र सव्यभागमारभ्य दक्षिणभागस्पर्शिनीभ्यां रेखाभ्यां एकः संयोगः प्रदर्श्यते सव्याद्दक्षिणभागमागच्छता बिन्दुसन्तानेनचापरः संयोगः प्रदर्श्यत इति । तद्यथा ॥

| | | |
|---|---|---|
| नवसागरकरस्य गन्ध- | ३ज+जी | नवसागरकरस्य |
| कायितम् | ग+३प्रा | जलकरहरितायितम् |
| चूर्णस्य जलकरहरि- | चू+प्रा | चूर्णस्य गन्धकायि- |
| तायितम् | ह+ज | तम ॥ |

एतावता ग्रन्थेन रसायनशास्त्रं सङ्क्षेपतोऽभिहितं तत्रेयमाकाङ्क्षा स्यात् यथा रसायनशास्त्रप्रतिपाद्यानि मिश्रामिश्रद्रव्याणि स्वतः सिद्धैः कतिविधैराकारैरुपलक्षितानि जगति प्राप्यन्त इति। अत्रोच्यते। पूर्वप्रकरणवर्णितानि द्रव्याण्याकारद्वैविध्याद् द्वेधा अशरीराणि सशरीराणि चेति। तत्र सशरीराण्यशरीरेष्वन्तर्भवितुमर्हन्ति कतिपयकालपर्यन्तमेव जीवनशक्त्याऽशरीरविलक्षणीकृतत्वात् जीवनशक्तेर्विचारस्तूत्तरतः करिष्यते अत इदानीमशरीरद्रव्याणां यादृशं रूपं स्वतः सिद्धं जगत्युपलभ्यते तादृशं सङ्क्षेपतः प्रदर्श्यते तत्र सुबहूनि द्रव्याणि खनिभ्यो निर्गम्यन्ते तानि च खनिजद्रव्याणीत्युच्यन्ते। अथ खनिजद्रव्याणि विभजते॥

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खनिजद्रव्याणि द्वेधा एकरसान्यनेकरसानिच ॥ १६ ॥

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। १ । तत्रैकरसान्येकोपादानजन्यानि अनेकरसानि त्वनेकोपादानजन्यानि तत्रैकमुपादानं रसायनशास्त्रविषयभूतं मिश्रममिश्रं वा विवक्षितं। यथा हीरकस्फटिकौ ॥

। २ । अतश्चैकरसखनिजखण्डगते महत्वाल्पत्वे न वि-

शेषाधायके पक्षद्वये ऽपि तद्गतावयवसाम्यात् तथाहि महता कठिनीखण्डेन कठिनीपर्वतेन वा दृष्टेन यावन्तः कठिनीगता विशेषाः परिचीयन्ते तावन्त एवाल्पकस्य खण्डस्य दर्शनेनेति ॥

। ३ । अथानेकरसखनिजानामेकरसखनिजमिश्रणफलत्वात् प्रथममेकरसखनिजपरीक्षणप्रकारमाह ॥

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खनिजस्वरूपपरिचयस्तदीया काराद्यसाधारण-
धर्मपरिचयाज्जायते ॥ १७ ॥

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। १ । तदीयाकारादीति । तत्र स्फटिकादयो बहवः खनिजाः स्वस्वजातिनियतेनाकारविशेषेण विशिष्टा एवोत्पद्यन्ते । तथाविधाश्चाकारा बहवः । ते चाकारनियमविद्यानाम्नि विद्याभेदे विशेषेण विस्तरेण निरूपिता इति ग्रन्थगौरवभयान्नेह प्रस्तूयन्ते ॥

। २ । अथ खनिजाः प्रायेण सर्वतो नियताकारा न सन्ति यतस्तेषामुत्पत्तिसमये तादृशानि प्रतिबन्धकानि सम्भवन्ति यद्वशात् तेषां स्वजातिनियत आकारः कस्मिंश्चित् पार्श्वे पार्श्वान्तरवत् सम्यङ् न प्रादुर्भवति । तथापि पार्श्वान्तरीयाकारदर्शनात् तत्स्वरूपपरिचयो भवति ॥

। ३ । अथ यत्रापि नास्त्याकारनियमस्तादृशस्थले काठिन्यजातीयगुरुत्वादिपरीक्षणेन खनिजस्वरूपनिर्णयः सम्पाद-

नीयः । तथाहि । द्वयोः खनिजयोर्मध्ये स एकः कठिनतरो येन स्वयमविलिखितेनापरो विलिख्यते । अतश्च यस्यां पङ्क्ता-वुत्तरः पूर्वं विलिखति तादृशपङ्क्तिविनिवेशितैः सुप्रसिद्धैर्दश-भिः खनिजैः काचन काठिन्यपदपङ्क्तिर्विरचिता ऽस्ति सा च प्रदर्शयिष्यमाणखनिजवर्गसम्बद्धा ॥

१ स्थितिस्थापकरहितमभ्रकम् । ६ स्फटीजनकाख्यप्रसिद्धप्रस्तरः
२ चूर्णगन्धकायितात्मकप्रस्तरः । ७ प्रसिद्धस्फटिकः ॥
३ चूर्णाङ्गारिकायितात्मकस्फटिकः । ८ पुष्परागः ॥
४ चूर्णकाचश्मायितात्मकस्फटिकः । ९ कुरुविन्दः ॥
५ चूर्णप्रकाशदायितात्मकस्फटिकः । १० हीरकः ॥

तथाच यदि कस्यचित् खनिजस्य काठिन्यपदं सप्तममस्तीत्युच्यते तर्हि तस्य काठिन्यं प्रसिद्धस्फटिकेन तुल्यमस्तीति ज्ञातव्यम् ॥

। ४ । एवं पारदर्शकेषु खनिजेषु किरणवक्रीकरणानुकूल-शक्तिरूपोऽसाधारणधर्मो विद्यते । तत्र महर्घा हीरकादयः खनिजा अतिशयेन तादृशशक्तिमन्तो भवन्ति । केचिच्चापरे न केवलं स्वोपरिपतन्तं वक्रीकुर्वन्ति अपितु तं द्वेधा विभजन्ते स च विभागः प्रत्येकं भिन्नां दिशं याति । अतस्तादृशखनिजानां पार्श्वविशेषद्वारा विलोकितस्य कृष्णरेखादिपदार्थस्य द्वे रूपे विलोक्येते इति ॥

। ५ । अथ यत्र स्थले उक्ताकारदार्ढ्यकिरणवक्रीकरणश-

क्यादिभिः खनिजस्वरूपनिर्धारणं न भवति तत्र रसायनप्रक्रियया तत्स्वरूपनिर्णयप्रकारमाह ॥

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रसायनशास्त्रोक्तयोरुष्णत्वेऽम्ले च वर्तमानया व्यासकरणशक्त्या खनिजाः परीच्यन्ते ॥ १८ ॥

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। १ । उष्णत्व इति । तथाहि । उष्णता खनिजानां परीक्षणे प्रायेण दीर्घया सूक्ष्मच्छिद्रविशिष्टया धमन्या प्रवर्तितया वह्निज्वालया नियुज्यते तथाच तत्तत्खनिजसंयोगेन ज्वालाया ये वर्णभेदा भवन्ति ते खनिजानां जातिभेदस्य विशेषेण दर्शका भवन्ति । यथा । लवणकराया योगेन ज्वालायाः किञ्चित्पीतता ताम्रस्य योगेन हरिततेत्यादि । अम्ल चेति । यथा । जलकरहरितिकाम्लयोगेन तत्तत्खनिजे आङ्गारिकाम्लस्य सत्त्वासत्त्वयोर्निश्चयो भवति यतो यद्याङ्गारिकमम्लं कस्मिंश्चित् खनिजे स्यात् तर्ह्यक्ताम्लसंयोगे सति तस्य तत्खनिजारम्भकद्रव्यान्तरविश्लेषो बुद्बुदोत्पत्तिक्रमेण जायमानः प्रत्यक्षीक्रियत इति ॥

। २ । अथ रसायनप्रकरणे प्रदर्शितमङ्गाराद्यमिश्रद्रव्याणां तन्मिश्रणफलानां चोद्देशक्रममनुसृत्य कांश्चिदेकरसान् खनिजान् प्रदर्शयितुं प्रतिजानीते ॥

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एकरसाः खनिजा हीरकादयो भवन्ति ॥ १९ ॥

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। १ । हीरकादय इति । तत्र हीरकः सर्वावयवावच्छेदे-नाङ्गारारब्धः कठिनतमो महर्घतमश्च तस्यचाष्टपार्श्वजातीय आ-कारो नियतः । अङ्गारो नियताकाररहित्यकाले प्रस्तराङ्गा-रादिरूपः प्राप्यते ॥

। २ । शुद्धस्य गन्धकस्य विषमकोणो ऽष्टपार्श्व आकारो भवति परन्तु प्रायेण स नियताकाररहित उपलभ्यते ॥

। ३ । स्वर्णस्य नियता आकारा अनेके सन्ति तथापि तद् बहुशो नियताकाररहितखण्डरूपेण कणरूपेण चोपलभ्यते ॥

। ४ । शुद्धस्य रजतस्य समकोणः षट्पार्श्व आकारो नियतः परन्तु तत् प्रायेण धात्वन्तरैर्गन्धकेनच मिश्रितं प्राप्यते ॥

। ५ । शुद्धस्य ताम्रस्य समपार्श्वकाकारनियमः क्काचित्कः तत्तु प्रायेण वृक्षाकारमुपलभ्यते ताम्राङ्गारमिश्रणफलस्य तु विषमकोणोऽनेकपार्श्वद्खण्डसदृश आकारो नियतो रूपं चास्य मरकतहरितमिति ॥

। ६ । शुद्धस्य लोहस्य लाभः क्काचित्कः किन्तु तत् प्रायः क्कचित् प्राणप्रदेन क्कचिच्चाङ्गारिकाम्लेन मिश्रितं प्राप्यते लोहग-न्धकमिश्रणफलस्य तु पञ्चकोणो द्वादशपार्श्वक आकारो निय-तो वर्णश्चास्य पीतभास्वर इति ॥

। ७ । सीसं प्रायेण गन्धकमिश्रितं लभ्यते । सीसगन्धक-मिश्रणफलस्य तु षट्पार्श्व आकारो नियतः । वर्णश्चास्य कृष्ण-शुक्लः ॥

। ८ । गुरुतमस्य कदाचित् षट्पार्श्वं आकारो नियत उपलभ्यते परन्तु प्रायेण तत् कणारूपं कर्कररूपं चोपलभ्यते ॥

। ९ । पारदो यद्यपि शुद्धो लभ्यते क्वचित् । प्रायशस्तु सिन्दूररूपेण गन्धकमिश्रो लभ्यते । तस्य वर्णो रक्तभास्वरः । स चात्यन्तानलसंयोगेन कृष्णीभवन्नपि शीतीक्रियमाणः पूर्वकं रक्तरूपं प्राप्नोति ॥

। १० । दस्तगन्धकमिश्रणफलस्य षट्पार्श्वादिराकारो नियतः । तस्य वर्णाश्च हरितः पीतो रक्त इत्यादयः ॥

। ११ । लघुतमं हरितिकाम्लमिश्रितं प्रायशःसूचीसदृश-विषमकोणानेकपार्श्वदण्डसदृशनियताकारविशिष्टे यवक्षारे प्राप्यते ॥

। १२ । लवणकरं हरितवायुमिश्रितं षट्पार्श्वरूपनियताकारविशिष्टं खनिजलवणरूपेण प्राप्यते ॥

। १३ । चूर्णकर आङ्गारिकाम्लमिश्रितो दुग्धप्रस्तरे चूर्णे कर्करे च प्राप्यते स च विषमकोणषट्पार्श्वरूपनियताकारविशिष्टः सन् अतिशयितां स्वोपरिपतितकिरणस्य द्वेधाविभागविशिष्टवक्रीकरणे ऽनुकूलां शक्तिं दधाति सो ऽयं धर्मो हिमद्वीपादायातेषु स्फटिकेषु विशेषेण दृश्यते ॥

। १४ । अग्निप्रस्तरिकाम्लात्मकस्य प्रसिद्धस्फटिकस्यारम्भको ऽग्निप्रस्तरकरो ऽस्ति । स च स्फटिकः षट्पार्श्वोभयतः शृङ्ग-

ण्डाकार: प्राप्यते स क्वचिन्नियताकाररहितोऽप्यस्ति क्वचित् पारदर्शक: क्वचिच्च न तथा। सोऽत्यन्तकठिनो लोहाघातेन स्फुलिङ्गान् किरत्यतो ऽग्निप्रस्तर इत्युच्यते। द्रव्यान्तरमिश्रणेनास्य सुबहूनि रक्तादीनि रूपाणि भवन्ति तादृशरूपविशिष्टाश्च गोमेदादयो बहव: प्रसिद्धस्फटिकस्य भेदा: सन्ति ॥

। १५ । अदाह्यपटजनको द्रव्यविशेषो ऽग्निप्रस्तरिकाम्लमिश्रितोऽभ्रकं जनयति। तच्च मृदु चिक्कणं प्रकाशद्वारदं च भवति। तत्पिण्डस्य स्थितिस्थापकरहितपत्ररूपाण्यनेकानि शकलानि सुकराणि भवन्ति। एवं शुक्लातिरिक्तवर्णस्य दार्ढ्यस्य चातिशये हेतुभूतैर्द्रव्यान्तरै: सहकृतेनानेनैवारम्भकेणाग्न्यतिथिनामक: खनिजो जनितो ऽस्ति। एभिरेवावयवैरारब्धस्य शृङ्गदीप्तिनाम्न: प्रस्तरस्य कदाचिदत्यन्तसुन्दरसूचीसदृश आकारो नियत: तस्य च जातिविशेषा: स्वैरनम्या भवंतीत्यतस्या सह मिश्रयितुं पटरूपेण प्रोतुं च शक्यंते ततश्च तेभ्य: पटेभ्यो वह्निसंयोगेनातस्या अपाकरणे ऽदाह्या: पटा अवशिष्यन्ते एभिरेव पटै: पुरा धनिकानां शवान्यावेष्ट्य प्रज्वलितान्यभूवन् येन काष्ठादिभस्मामिश्रितानि तच्छरीरभस्मानि तेषां परिजनै: प्राप्यन्त ॥

। १६ । स्फटीजनकं कुरुविन्दस्यारम्भकं भवति कुरुविन्दस्य स्फटीजनककिट्टमात्रजन्यत्वात्। इन्द्रनील: पद्मरागो मरकत: पुष्पराग इत्यादय: कुरुविन्दस्य भेदा: सन्ति। स्फटीजन-

रेण वियुज्यतेच एतद्विपरीतस्वभावा वृत्तजातिरङ्गारेण संयुज्यते प्राणप्रदेन वियुज्यतेचेति पूर्वं सूचितम् ॥

। ८ । अथ जङ्गमशरीरनिरूपणाङ्गभूतं तच्छरीरजातिभेदनिरूपणमारभते ॥

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जन्तूनां चत्वारो वर्गा भवन्ति पृष्ठवंशविशिष्टः कोमलशरीरविशिष्टः काण्डविशिष्टः समानावयवावृतनाभिविशिष्टश्चेति ॥ २७ ॥

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। १ । तत्र प्रथमवर्गजाताः पृष्ठवंशविशिष्टा यथा मनुष्यादयः । द्वितीयवर्गजाता अतिकोमलशरीरविशिष्टाः प्रायः शुक्त्यन्तर्गता भवन्ति यथा शम्बूकादयः । तृतीयवर्गजाताः काण्डविशिष्टशरीरा यथा शतपदादयः । चतुर्थवर्गजाता अभितोऽवयवविशिष्टा यथा जलनीलीव्याप्तसलिले सञ्जाता ह्रस्वा प्रायः सूक्ष्मदर्शकयन्त्रेण दृश्या जन्तुविशेषाः ॥

। २ । अथ प्रथमवर्गस्य चत्वारो भेदा भवन्ति तत्र प्रथमे सस्तना द्वितीये पक्षिणस्तृतीये सर्पाश्चतुर्थे मत्स्याः ॥

। ३ । अथ सस्तनाः पुनर्द्वादशधा भवन्ति । ते यथा द्विहस्ता मनुष्याश्चतुर्हस्ता वानरा हस्ताभ्यां उड्डीयमाना वातुल्यः कीटभोजिनश्छुच्छुन्दर्यादयो मांसभोजिनो व्याघ्रादयो जल-

स्थाः शिशुमारादयः स्थूलचर्म्मिणो गजादयो रोमन्थकरा वृषादयो अदन्ता वज्रकीटादयः कर्त्तनकरा मूषिकादयः पेशीविशिष्टाः कङ्गरूसंज्ञका जन्तुविशेषाविरामूत्रैकमार्गविशिष्टा ये चञ्चुविशिष्टाश्चतुष्पदा अस्त्रेलियाख्ये देशे निवसन्ति ॥

। ४ । अथावशिष्टानां त्रयाणां वर्गाणां प्रत्येकं बहवो भेदा भवन्ति ते विस्तरभयादिह नोच्यन्ते ॥

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इति श्रीमज्जेम्सब्यालन्टाइनविरचितायां न्यायकौमुद्यां रसायनजीवनविचारो नाम पञ्चमोऽध्यायः ॥

। ३ । अथ शिलासम्बन्धिनामाकाराणामवयवसंस्थानानां च विचारनारभते

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शिला द्वेधा क्रमिकस्तराकारा अतथाविधाश्चेति ॥ १ ॥

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। १ । तत्र क्रमिकस्तराकाराणां शिलानां दर्शनादिदमनुमीयते यत् सर्वे स्तरा युगपदेव नोत्पन्ना अपि तु तेषामवयवसङ्घातः शनैः शनैः क्रमेणैव जात इति । यथा । शोणनदसम्भेदादधस्ताद् गङ्गायास्तले प्रथमं कश्चिद् गङ्गापूरवशान्मृत्ति-

कास्तरः पतितो ऽथो गङ्गापूरे निवृत्ते शोणपूरबलान्मृत्तिकास्त-
रोपरि वालुकास्तरः पतित एवं क्रमेण दश पञ्च स्तराः सञ्जा-
तास्ततः शरदि कृशतां गच्छता गङ्गाप्रवाहेणोक्तस्तरोच्चयस्यैकः
प्रान्तः खण्डित एवं स्थिते तद् विलोकयता येन केनापि नीचै-
र्वर्तमानस्तरस्य प्रथममुपरिवर्तमानस्तरस्य चोत्तरमुत्पत्तिरिति
गृहभित्तिघटकेष्टकाचयानामिव तेषां स्तराणां क्रमनिर्णयः सु-
कर इति ॥

। २ । इमामेव रीतिमालम्ब्य भूगर्भविवेचननामकविद्या-
प्रेप्सुभिः सर्वस्मिन् भूमण्डले गम्यप्रदेशेषु गत्वा भूगोलपुटभू-
तशिलाजातीनां मध्ये कस्या जातेः का जातिरुपरि तिष्ठति का
च कस्या अधस्तिष्ठतीति सम्यङ् निर्णीतम् । तत्र याः शिलाजा-
तयः शिलैकविषयेषु ग्रन्थेषु सविस्तरं निरूपिता अनतिप्रयोज-
नाश्च ता विहायान्यासमुपर्यधोभावक्रमं दर्शयितुं द्वादश शिला-
जातीरुद्दिशति तत्र च नाम्नां पौर्वापर्येण तन्नामकशिलाजाती-
नामुपर्यधोभावो बोद्धव्यः ॥

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कणोच्चयसन्निभो ऽभ्रकीयप्रस्तरफलकः पङ्कमय-
प्रस्तरफलकः कृष्णशुक्लफलकः पुराणारुणवालुका-
प्रस्तरः पार्वतसुधाप्रस्तरः प्रस्तराङ्गारस्तरो नवीन-
वालुकाप्रस्तरः कठिनी कल्पनच्चमपङ्को भिन्नखटि-

तत्प्रस्तरकक्षा मृत्स्ना चेति द्वादश प्रधानभूतपुटरूपाः शिलाजातयः सन्ति ॥ २ ॥

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। १ । नन्वासां भूगोलपुटभूतस्तररूपेण स्थितानां शिलाजातीना प्रत्येकं क्वचित् क्वचित् कतिपयशतहस्तमितघनत्वतया तासां स्थितिपौर्वापर्यविनिश्चयो दुःशकः । तावद्दूरदेशे मनुष्यस्य गमनसामर्थ्याभावात् । तथाच भूगर्भविवेचननामकविद्येष्स्भिः केनोपायेन शिलाजातिपौर्वापर्यं विनिश्चतमिति । अत्रोच्यते । न तावत् सर्वत्रैवोपरितनपुटेनाधस्तनपुटानि पिहितान्येव भवन्ति । किन्तु क्वचिद् देशे केनचित् कारणेन तेषां समुदाय एकप्रान्तावच्छेदेनोत्थापितो ऽपि भवति तत्र तु सर्वेषां स्तराणां प्रान्ता गृहभित्त्यन्तर्गतेष्टकासमुदायप्रान्तवद् दर्शनगोचरा भवितुमर्हन्ति तेन च तासां क्रमनिर्णयो ऽपि सुशक इति ॥

। २ । अथैवंविधा ये शिलाजातीनां पूर्वसिद्धस्योपर्यधोभावस्य विपर्यासाः कस्मिंश्चिद् देशे दृश्यन्ते तेषां तीव्रतरबलविशेषकार्यत्वमनुमानेन निर्णीतमतो हेतोः सम्प्रत्यपि तथाविधक्रमविपर्यासकारणीभूताः बलविशेषाः क्वचित कार्यकरणे प्रवृत्ताः सन्ति नवेति जिज्ञासायां ज्वालामुखीपर्वतानां तप्तकुण्डानां च तत्त्वस्यान्वेषणेन तादृशबलविषये यन्निर्णीतं तद् वक्तुं सूत्रयति ॥

भूगोलपृष्ठे सूर्यकिरणसम्बन्धजन्याया उष्णताया देशभेदेन परिमाणभेदे ऽपि भूपृष्ठमारभ्य हस्तशतकमितात् प्रदेशादधस्तात् सर्वत्रैकपरिमाणिकैवोष्णता ततः स्थलाच्चधस्तनत्वोत्कर्षादुष्णतायास्तथोत्कर्षो यथा ऽन्ते भूकेन्द्रसमीपप्रदेशो ऽग्निना द्रुतो ऽस्तीति सम्भाव्यते ॥ ३ ॥

। १ । अनयैवाभ्यन्तरोष्णतया ज्वालामुखस्तप्तकुण्डानि च सञ्जातानीत्यनुमीयते ॥

। २ । अपिचेदमपि सम्भाव्यते यत पुरा कदाचिदेष भूगोलो ऽतितप्तभास्वरद्रवपिण्डरूपः स्थितः स्यात् तत्रत्यानि जलान्यपि तदा बाष्परूपाणि स्थितानि स्युः न च कोऽपि प्राणी वृक्षो वा भुवि स्थितः स्यादिति अथानन्ताकाशरूपे ऽवकाशे किरणरूपेण स्वान्तर्गतोष्णताप्रसरणात् किञ्चिच्छीतीभवति भूगोले तस्योपरि शीतीक्रियमाणाद्रुतसीसकस्योपरीवावरणरूपं पटमेकं सञ्जातं स्यात् एवमेवाग्रे यथा यथा भूगोलस्य शीतीभवनं प्रवृत्तं तथा तथा जलान्यपि बाष्परूपतां विहायाधुनोपलभ्यमानद्रवरूपेण संहतानि स्युरितिच ॥

। ३ । एवंविधावस्थासम्भावनया चापाततः प्रथममिदं प्रतीयते भूपिण्डः सर्वात्मना गोलरूपो ऽस्तीति परन्त वस्तुतो

विचार्यमाणे यत् सम्भाव्यते तदुच्यते। तथाहि । यथा गङ्गादिनदीजलस्थाः पङ्कस्तरास्तज्जलावतरणानन्तरं शुष्कत्वकाठिन्यक्रमेण चतुष्कोणशकलरूपेण विभज्यन्ते तथा शीतीभवन्ति पृथ्वीपुटान्यपि भज्यन्त एव । अथ जलानि तथाविधानां भूपुटशकलसन्धिच्छिद्राणां द्वारेणान्तर्यथा यथा प्रविशन्ति तथा तथा स्वीयया विलयानुकूलशक्त्या तानि शकलानि विस्तारं नयन्ति ततश्च तनुभूपुटं भित्त्वा भुवो गर्भं विशन्ति यो ऽत्याप्यत्यन्ततप्तो वर्तते तयोश्च संयोगे महान् बाष्पसङ्घ उत्पद्यते स चात्यन्तिकस्वस्वरूपप्रसरणशक्तिमत्तया परितः सर्वान् देशानकुण्ठितेन बलेन पीडयन्नितस्ततो भूपुटमुत्थापयति तेन च भूपृष्ठे गोलप्रायाकारविशिष्टा द्रुतपार्थिवांशगर्भाः सुमहान्तः पिण्डाः प्रादुर्भवन्ति । यत्रतूत्थाप्यमानं भूपुटं भज्यते तत्राभ्यन्तरो द्रुतः पार्थिवांशो बाष्पेण बहिर्निर्गमितो भुवः पृष्ठे समागत्य शुष्यन् दृढो भवति सो ऽयमेव प्रकारः पुरातनानामुच्चभूभागानां पर्वतानां चोत्पत्तिरभूदिति सम्भाव्यते ॥

। ४ । अथैवं निष्पन्नानां हिमालयाद्युच्चपर्वतानां शिखराणि सर्वदा हिमसङ्घाहतान्यत्यन्तशीतानि तत्रत्यएव हिमसङ्घो गङ्गादिमहानदीनां निदानं ताश्च नद्यः पर्वतशरीराद् विश्लिष्टान् मृत्पाषाणादिसङ्घान् प्रवाहबलेनाधो नयन्ति एतेनैव क्रमेण गङ्गाप्रवाहवशात सुन्दरवनाख्यं स्थलमुत्पन्नम् । अतएव

यदि सुन्दरवनभूगर्भे तालवृक्षकाष्ठानि मकरव्याघ्रहरिणा-दीनामस्थीनि चोपलभ्यन्ते तर्हि नैतदस्मान् विस्मापयति यतः सुन्दरवनभूमिस्तदेव पदार्थजातं बिभर्ति यत् किमपि पर्वतभू-विश्लिष्टं तालवृक्षोद्गमव्याघ्रादिनिवासस्थानसमीपादागतया ग-ङ्गया समनीयत इत्यस्माभिर्निश्चितम्। तदेवं यासां क्रमिक-स्तराकारशिलानां गर्भे जन्तुवृक्षशेषा उपलभ्यन्ते ताः सर्वाः सु-न्दरवननामकस्थानारम्भकपङ्कोच्चयवत् पुरा कदाचिज्जलविली-नमूर्तयोऽभूवन्। अपिच तत्र तत्रोपलभ्यमानावयवाः प्राणिनो वृक्षाश्च तत्तच्छिलोत्पत्तिकालजीविन आसन्निति च प्रतिलोमा-नुमानेन निश्चीयते॥

।५। एवंविधप्राणिवृक्षावशेषोपलब्ध्या तत्र तत्र देशेऽत्य-द्भुतविविधप्राणिसत्त्वं निर्णीतम्। तद् यथा। प्राचीनकालिको हस्ती हस्तपञ्चाधिकोच्छ्रायो हस्तैकादशकाधिकदैर्घ्यविशिष्टो रोमाक्रान्तशरीरश्चासीत् तस्य दन्तावतिपृथू कुटिलतरौ दैर्घ्ये करषट्कमितावास्ताम्। प्राचीनकालिको महामकरो दैर्घ्ये त्र-यस्त्रिंशद्धस्त आसीत् तस्यास्थीनि यत्राधुना शीतवशान्न कश्चन मकरः स्थातुं शक्नोति तस्मिन्निङ्ग्लण्डदेशे प्राप्नुवन्ति। प्राक्तनी महागोधा सप्तचत्वारिंशद्धस्तदैर्घ्या ऽभवत्। पुरातनो मकर-विशेषो विंशतिकरदैर्घ्यो नरशिरः स्थूलनेत्र आसीत् सचाधुनि-कमकरवत् स्थलपादैर्गन्तुं समर्थो नाभत् पादाभावात् अपित

जलसञ्चारानुकूलानां पक्षिपक्षविलक्षणां पक्षाणां सत्वान्मत्स्य इव जले गन्तुमलमासीत् स च मत्स्यमकर इति व्यवह्रियते । अन्यश्च दीर्घग्रीवमत्स्यमकरनामक आसीत् यस्य शिरो ऽत्यन्तमल्पं ग्रीवा च सर्पवद् दीर्घा ऽभवत् । अन्यस्य चोड्डीयमानमकरसंज्ञकस्य यथार्थनाम्नः पक्षद्वयं वातुलिपक्षवन्मुखं च मकरमुखवदासीदिति ॥

। ६ । तदेवं वह्निजलयोर्भूपुटभूतशिलाहेतुता निरूपिता तत्र पौराणिकीं रीतिमाश्रित्येहापि जलाधीनोत्पत्तिकानां शिलानां वारुणशिलापदेन वह्न्यधीनोत्पत्तिकानां चाग्नेयशिलापदेन व्यवहारो लाघवात् क्रियते । अथ पुरा भूपुटानां तनुत्वमाभ्यन्तरोष्णतायाः सान्निध्यं चासीदिति विभावनया तदानीं जलपृष्ठ्व्योरधनातनोष्णत्वाधिकोष्णताविशिष्टत्वं सम्भाव्यते ततश्च तदा तात्कालिकोष्णतासहनक्षमाणामेव वस्तूनां पृथ्व्यामुत्पत्तिर्बभूव न त्वन्येषामिति सिद्ध्यति । एतेन शीततौ नदीनामावरणघनीभावकारिणो हिमसञ्चयस्य भयेन साम्प्रतमिङ्ग्लण्डदेशे नोत्पद्यमाना अपि मकरास्तत्रत्यासु नदीषु पुर्वं कथमुद्बभूवुरेवमधुना तत्राप्ररोहन्तो ऽपि तालवृक्षाः पुरा कथमिङ्ग्लण्डदेशे प्रादुरभूवन्नित्यादयः शङ्काः परास्ताः । किञ्चोष्णतायाः पदविशेषा एव देशविशेषे प्राणिवृक्षविशेषोत्पत्तौ कारणमित्यत्र प्रत्यक्षमपि प्रमाणमस्ति तथाहीङ्ग्लण्डदेशे सम्प्रति महत्सु सम्यगुपायेनोष्णीकृतेषु काचगृहेषु तालवृक्षाः साधु प्ररोहन्ति तथा भारतवर्षात्

तत्र नीता मकराः स्वीयजन्मभूमाविव वर्द्धन्ते ॥

। ९ । अथ शुष्यतां पृथ्वीपुटानां मध्ये मध्ये छिद्राणि सञ्जायन्त इति पूर्वमुक्तं तत्र तानि भूगोलस्य शोषात् स्वान्तःप्रविष्टजलनिष्टाविलयानुकूलशक्तिवशाद्वा क्रमेण विरोपितानि भवन्ति क्वचित्तु जातान्येवंविधानि छिद्राण्यत्यायतत्वाद्वेत्यन्तरवशाद् वा ऽद्यावधि यथापूर्वं स्थितानि तेषां नाम दर्शयति ॥

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जलं भूगोलस्यातितप्तमभ्यन्तरदेशं प्रविश्य तत्रत्यान सुतप्तान् पार्थिवांशान् येषां द्वारेण बहिर्निस्सारयति तानि छिद्राणि ज्वालामुखीपदेन व्यवह्रियन्ते ॥ ४ ॥

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। १ । तत्रैवंविधा ज्वालामुखी वङ्गदेशीयसमुद्रशाखायां वन्ध्यद्वीपनाम्ना प्रसिद्धा ऽस्ति ॥

। २ । यदा तावद् भूपुटं भज्यते तदा तस्य ज्वालामुखीनामकस्य बहिर्महता वेगेन निःसरन्नतितप्तः पार्थिवांशस्तस्य पर्वतस्य परितो वहन्नधो याति येन येन च वस्तुना संयुज्यते तद विनाशयति अथ स कालेन शुष्यन् पूर्वोक्तो ज्वालामखीप्रस्तरनामकः खनिजो भवति ॥

। ३ । अथ ज्वालामुख्यः कतिपयकालापगमे ऽन्तर्धानं यान्तीति बहुषु स्थलेषु दृष्टं तत्रातीतानां ज्वालामुखीनामनुमि-

तिस्तत्र तत्र देशे ज्वालामुखीमुखभूतछिद्राणां दर्शनाद् वर्तमानज्वालामुखीसम्बन्धिप्रस्तरसदृशदृढप्रस्तरदर्शनाच्च भवति ॥

। ४ । एवंविधयैव युक्त्या क्रमिकस्तराकाररहितानामाग्नेयशिलानां पूर्वकालिकमत्यन्तोष्णसंयोगजन्यद्रुतत्वमनुमीयते यतो यथेष्टकापाकगृहस्याभ्यन्तरभाग इष्टकापाकोत्तरमत्यन्तदृढो रक्तश्च भवति ततश्च चिरकालोत्तरमपि येन केनापि तन्नागतेनेष्टकापाको जात इत्यनुमातुं शक्यते तथा यान् भूपुटरूपान् वाक्यशिलास्तरान् विभिद्य भूगर्भान्निर्गच्छन् द्रुतपार्थिवभागाः स्वसंयोगस्थाने दृढान् कृतवांस्तेषां तत्स्थानदर्शनाद्दतितप्तपार्थिवभागसम्बन्धो ऽनुमीयते ॥

। ५ । अथ क्रमिकस्तराकाररहिताश्चतस्रः शिलाजातिर्वक्ष्यति तत्रापि नाम्नां पौर्वापर्यात् प्राचीननवीनभावो ऽवगन्तव्यः ॥

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कणोच्चयो हरितप्रस्तरः स्फटिककिर्मीरितः कृष्णप्रस्तर इतीमाश्चतस्र आग्नेयशिलाजातयो भवन्ति ॥ ५ ॥

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। १ । तत्र कणोच्चयनामको हरितप्रस्तरात् पूर्वं सिद्धो यतो हरितप्रस्तरः कणोच्चयसङ्घातं भित्त्वा निर्गतः तुल्ययुक्त्या हरितप्रस्तरः स्फटिककिर्मीरितात् स च कृष्णप्रस्तरात् पुराण इति

सिद्यति । आधुनिकज्वालामुखीमुखनिर्गच्छत्प्रस्तररूपा सर्वतो नवीना ऽऽग्नेयशिलाजातिर्ज्वालामुखीप्रस्तरनाम्निका ऽस्ति ॥

। २ । अथ भूगर्भविवेचननामकविद्याभेदैकसम्बन्धिषु ग्रन्थेषु प्रदर्शितानां चित्राणां दर्शनात् क्रमिकस्तराकाराणामतथाविधानां चोभयविधानामपि शिलानां पूर्वापरीभावरूपः सम्बन्धो विज्ञायते तस्योपयोगमाह ॥

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शिलाभेदानां पूर्वापरीभाववि़ज्ञानं खनिजीविनां
महत उपयोगाय भवति ॥ ६ ॥

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। १ । अत्रेदमवधेयम् सप्तमे सूत्रे येन क्रमेण क्रमिकस्तराकाराः शिलाजातयः प्रदर्शितास्ताः सर्वाः सर्वत्र तत्रैवाखण्डितेन क्रमेण यद्यपि नोपलभ्यन्ते तथापि तत्सूत्रोक्तमुपर्यधोभावं ताः कदाचिदपि नातिक्रामन्ति । यथा । पङ्कमयप्रस्तरफलकः प्रस्तराङ्गारस्योपरि न क्वचिदुपलभ्यते न च कठिन्या उपरि प्रस्तराङ्गार इत्यतो यत्र भूपृष्ठे पङ्कमयप्रस्तरफलक उपलभ्यते तत्र भूगर्भे प्रस्तराङ्गारलाभाय खननं निरर्थकमेवैवदिगन्यत्राप्यनुसर्तव्या । तथाच क्रमविज्ञानान्निरर्थकाः श्रमावित्तव्ययाश्च निवर्तन्त इति ॥

। २ । तदेवं भगर्भस्थान् पदार्थांस्तेषां क्रमं तद्धेतूंश्च निरूप्येदानीं भूपृष्ठगुणविवेचननामिका विद्या प्रस्तूयते । तत्रादौ

स्थलजलविभागमाह ॥

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भूगोलपृष्ठस्य त्रयः पादाः समुद्रावृताः सन्ति । महान्तः स्थलविभागा भूगोलस्योत्तरखण्डे वर्तन्ते महान्तः समुद्रजलविभागाश्च दक्षिणे खण्डे सन्ति ॥ ७ ॥

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। १ । तत्रैशिययुरोपाख्यखण्डद्वयात्मकः स्थलविभागो भूगोलस्यैकस्मिन्नर्द्धे पश्चिमामारभ्य पूर्वां यावद् विततोऽस्ति अमेरिकाखण्डात्मकः स्थलविभागस्तु भूगोलस्यापरस्मिन्नर्द्धे दक्षिणामारभ्योत्तरां यावद् विशेषविततोऽस्ति ॥

। २ । सर्वे महान्तः स्थलविभागा दक्षिणस्यां दिशि प्रवणप्रदेशरूपेण परिसमाप्यन्ते । एष धर्म आफ्रिकामेरिकाख्यस्थलविभागयोर्विशेषेण दृश्यते भारतेऽर्वदेशे मलाकादेशे ग्रीसदेश इतलीदेशे च कथञ्चिद् दृश्यते ॥

। ३ । सर्वे महाद्वीपनामकाः स्थलविभागा समुद्रतीरमारभ्याभ्यन्तरभागं प्रति क्रमेणोच्चा भवन्ति । सर्वेषु महाद्वीपेषु क्रमोच्चत्वातिशयसीमा केन्द्राश्रिता न भवत्यपितु सा समुद्रतीराद् यावत्यन्तरे महाद्वीपस्यैकस्मिन् पार्श्वे वर्तते ततोऽल्पतरेऽन्तरे तस्यापरस्मिन् पार्श्वे वर्तते । युरोपैशियाऽऽफ्रिकाख्यखण्डद्वयरूपायां प्राचीनभुवि सैषा क्रमनिम्नता दक्षिणोत्तरसंस्था दृश्य-

ते । अमेरिकाखण्डरूपायां नवीनभुवि तु सा पूर्वपश्चिमसंस्था दृश्यते ॥

। ४ । तत्र प्राचीनभुवि मुख्याः प्रवणप्रदेशा रशियाख्यखण्ड-मध्यस्थोच्चप्रदेशादारभ्यन्ते तस्यह्युत्तरस्यां सिबीरियाख्यदेशात् समुद्रपर्यन्तं त्रयोदशशतं क्रोशान् भूमिः प्रवणा भवति दक्षि-णस्यां तु प्रवणताया आरम्भः केवलं समुद्राद्विशतक्रोशान्तरे वर्तते । तथा नवीनभुवि दीर्घा मन्दप्रावण्यवती भूमिः पूर्वस्यां दिशि वर्तते पश्चिमायां तु संकुचिता परमप्रावण्यवती भूमि-र्वर्तते ॥

। ५ । अयंचान्योऽपिप्राचीननवीनभूम्योर्विशेषो यत् पूर्व-स्यां समानभूमयो ऽतिवितताः समुद्रपृष्ठादत्युन्नताः सन्ति पर-स्यांतु समुद्रपृष्ठादत्यल्पोन्नताः समभूमयो भवन्ति । तथाहि रशियाख्यखण्डमध्ये ऽतिविशालया पर्वतश्रेण्याविधृताः समुद्र-पृष्ठात् त्रिसहस्रहस्तमितामुच्चतामारभ्य नवसहस्रहस्तमितोच्च-तापर्यन्तमुच्चताविशिष्टाः समभूमयो वर्तन्ते ॥

। ६ । महानदीनां मार्गो दैर्घ्यं पर्वतश्रेणीनां दिशमुच्चतां चाश्रितमस्ति । अथ महापर्वते कथं महानद्युत्पत्तिरिति चेत् तज्ज्ञापनार्थं सूत्रम् ॥

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उपर्यच्चतशिखराणि शीतानि सन्ति तत्र काचित्
सीमा वर्त्तते यत ऊर्द्धं वर्तमानानि पर्वतशिखराणि

सर्वदा हिमावृतानि भवन्ति ॥ ८ ॥

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। १ । यथा यथा भूपृष्ठादुच्चत्वं तथा तथा वायुगतोष्णताया न्यूनत्वात् सर्वेषु देशेषु काचिदुच्चतायाः सीमा वर्त्तते यस्यां वायोर्घनीभवज्जलतुल्यमुष्णताल्पत्वं भवति । इयंच सीमा हिमसीमाख्या तत्तद्देशस्योष्णतानुसारेण भिद्यते । यथा हिमालये समुद्रपृष्ठात् हिमसीमा १०००० हस्तान्तरे । युरोपदेशदक्षिण प्रदेशेतु भारतवर्षस्योष्णताया न्यूना उष्णता वर्त्तते तत्रापि समुद्रपृष्ठाद्धिमसीमाया उच्चता ६००० हस्तान्तरे ध्रुवसमीपेतु हिमसीमा समुद्रपृष्ठेन समा वर्त्तते ॥

। २ । अथ हिमावृतपर्वतोत्पन्ननदीनां विशेषधर्म्मज्ञापनाय सूत्रम् ॥

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वृष्ट्यभावे ऽपि ग्रीष्मकाले हिमपर्वतजातानां नदीनां वृद्धिः ॥ ९ ॥

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। १ । काशीसन्निहितगङ्गानद्या एष धर्म्मः प्रसिद्धः । तस्यच कारणं गङ्गाया हिमालयोत्पन्नत्वमेवोच्यते ॥

। २ । यथा उष्णकाले गङ्गा वर्द्धते तथा मिस्राख्यदेशे नीलनद्यपि वृद्धिं याति । अथ वक्ष्यमाणं नीलाख्यनदीवृद्धिकारणवर्णनमितिहासकर्त्तुर्यवनस्य हीरादतनामकस्य ग्रन्थादुद्धृतम् ।

अयं हीरादत्तो विक्रमादित्यशककारककालात्पूर्वं सप्तविंशत्युत्तरचतुःशतवर्षान्तरेऽभूत् ॥

। ३ । हीरादत्त उवाच । नीलाख्यनदीविषये यद्यपि तद्देशीयपण्डिता अन्ये च बहवो मया दृष्टास्तथापि न किञ्चित् तेभ्यः समाधानं प्रापि । सायनकर्कसंक्रमानन्तरं शतं दिनानि नीलाख्यसरिद्वर्द्धते । ततो ह्रसमाना नातिशीतकालेऽल्पीयसी जायते । अथ केन कारणेनान्यनदीविकारविलक्षणोऽस्यां नीलनद्यां विकारो दृश्यत इति मिस्रदेशवासिषु दृष्टेषु न कस्माच्चन समाधायकमुत्तरं लब्धम् । अथ कतिचन यवनाः स्वीयपाण्डित्यद्योतनेच्छया नीलनदीवृद्धिविषये त्रीणि वर्णनानि चक्रुः । तत्र प्रथममुच्यते । उष्णकाले उदग्वायुर्वहति अनेन तस्याः समुद्रावरोधे जाते तत्काले सा वृद्धिमेतीति । परमेतद्वर्णनं न समीचीनं यतः तस्मिन्काले उदग्वातवहनाभावेऽपि तस्या वृद्धिः पूर्ववज्जायते इति बहुधा दृश्यते किञ्च यदि उदग्वायुर्वृद्धिहेतुः स्यात् तर्हि यावत्यो नद्यः सौम्यवाहिन्यः स्युस्तासामपि तद्वद्विकारः स्यात् तासु चाल्पवेगवत्योऽधिकवृद्धिमत्यः स्युः किन्तु या बह्व्योऽन्या उदग्वाहिन्यो नद्यो ता नीलनदीवद्विकृता न भवन्ति ॥

। ४ । अथ द्वितीयवर्णनम् । वर्णयितृमते समुद्रोऽपि नदी भवति तेनेयं पृथ्वी आवृतास्ति । अतोऽस्या नद्याः समुद्रोत्प-

ज्ञत्वादियं वर्द्धते इति परमेतदपि वर्णनमसमीचीनम् । यतः समुद्रविषये यदत्र वर्णितं तत्तु प्रमाणशून्या अस्पष्टार्था किंवदन्ती अस्ति । समुद्रोऽपि नदी भवतीति तु न मया श्रुतम् यत्तु कदाचित् होमराख्योऽन्ये वा कतिचन प्राचीनकवयस्तादृशमर्थं लब्ध्वा तं स्वकाव्यग्रन्थेषु वर्णयाञ्चक्रुस्तत्तु चमत्कारार्थमेव ॥

। ५ । तृतीयवर्णनम् । हिमद्रवीभवनेन नदी वर्द्धत इति । नैतदपि सुन्दरम् । यतः इयं नदी याम्यदेशान्निर्गता सौम्यदिशं वहन्ती सती मिस्राख्यदेशमवरोहति । एवं उष्णदेशाच्छीतदेशमायान्त्या एतन्नद्या वृद्धिः हिमाज्जात इति कथं वक्तुं शक्यते । हिमजातवृद्ध्यनुपपत्तौ बहवो हेतवो भवन्ति येभ्यो यस्य कस्यापि तद्विषये संशीतिविच्छित्तिः स्यात् । तत्रादौ । नद्युत्पत्तिदेशादुष्णो वायुर्वहतीति उक्तवृद्ध्यनुपपत्तौ स्फुटो हेतुः । अथ च तद्देशीया मनुष्या उष्णतया कृष्णवर्णा भवन्ति किञ्च उष्णदेशप्रिया आकाश्यः सदैव तत्र वसन्ति क्रौञ्चपक्षिणश्च शीतकाले सौम्यदेशादागत्य तत्र वसन्ति । परं यदि तत्र किञ्चिदपि हिमं वर्षेत् तदेदं सर्वं न घटेत ॥

। ६ । सकलयाऽनया हीरादतस्योक्त्या स उच्चपर्वतस्योष्णताया नीचदेशस्योष्णतायाश्च पूर्वोक्तं भेदं नावागच्छदिति स्फुटमवगम्यते । अथ ये पर्वतसम्बन्धिघटना जानन्ति ते नीलाख्यनदी ग्रीष्मकाले वर्द्धत इत्यस्य श्रवणमनु इयं नदी हिमस्रेण्या

उत्पद्यत इति तर्कयेयुः । अथ यथा गङ्गाया हिमस्थानान्निर्गमः प्रत्यक्षः तथाऽधुना नीलनद्या अपि प्रत्यक्षोऽभूत् ॥

। ७ । अथ यो हिमालयपर्वते परिभ्रम्य अगाधेयकूटान् तदुत्पन्नप्रवाहांश्च व्यस्तानीक्षेत स तेषु काचित् क्रमसंस्थितिर्वर्त्तत इति कदाचिदपि नोहेत किन्तु यो भङ्गिद्वारा तान् युगपत् पश्येत् स तेषु कश्चन नियतः क्रमः संस्थितिश्चास्तीति जानीयात् । संक्षिप्तवर्णनस्याकांक्षायां तत्र सूत्रम् ॥

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भारतवर्षस्योत्तरदिशि पूर्वापरो हिमालयपर्वतस्य विस्तरः ॥ १० ॥

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। १ । अस्मिन् पर्वते अनेके मार्गाः सन्ति यानारुह्य यात्रिणः पारेपर्वतं गन्तुं शक्नुवन्ति । ते घट्टाख्या मार्गा यस्यां हिमावृतपर्वतश्रेण्यां वर्त्तन्ते सा पर्वतश्रेणी हिमघट्टश्रेणीत्यभिधीयते ॥

। २ । अथ मुख्यशिखराणामपेक्षायां सूत्रम् ॥

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हिमालयपर्वतस्य मुख्यशिखराणि स्वस्वपर्वतश्रेणीसहितानि घट्टश्रेणीदक्षिणदिशि विस्तृतानि सन्ति ॥ ११ ॥

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। १ । गङ्गानद्युत्पत्तिस्थानं यद् जम्नौत्रीशिखरं तत्प्रभृति यथाक्रमं मुख्यशिखरनामानि कथ्यन्ते । तथाहि । जम्नौत्री नन्ददेवी धवलगिरिः गोस्वामिस्थानं कञ्चनगिरिः चमत्कारी गिरियुग्मञ्च ॥

। २ । अथ तत्सम्बन्धिनदीव्यवस्थासूत्रम् ॥

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तत्तत्पर्वतश्रेण्यन्तर्गता बहवः प्रवाहाः क्रमेण एकीभूय तत्र तत्र एकां नदीमुत्पादयन्ति ॥ १२ ॥

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। १ । तथाहि जम्नौत्रीपर्वतोऽस्ति यस्योच्चता १७११२ हस्तपरिमिता अपिच नन्ददेवी यस्योच्चता १७१२८ हस्तपरिमिता । तच्छिखरद्वयसम्बन्धिपर्वतश्रेणीद्वयमध्ये ये ये गलितहिमोत्पन्नाः प्रवाहाः सन्ति ते क्रमेण मिथः संयुक्ता भवन्ति तत्स्थानस्य कटाहाकृतित्वात् । अतस्तत्र अनेकेषु अनल्पेषु पर्वतेषु गङ्गौत्रीतीर्थसमीपस्थकेदारनाथाख्यादिषु सत्स्वपि सर्वे सरित एकीभूय गङ्गानदी भवन्ति ॥

। २ । एवमेव नन्ददेवीशिखरोपश्रेण्या धवलगिरिशिखरोपश्रेण्याश्च मध्ये अनेका नद्यः एकीभूय घर्गटसंज्ञिकां कर्णाटिनदीमुत्पादयन्ति । साच गङ्गया सह सङ्गमेति ॥

। ३ । पुनः धवलगिरिशिखरगोस्वामिस्थानशिखरयोर्मध्ये

सप्तगण्डक्याख्याः प्रवाहा वहन्ति तेच मिलित्वा गण्डकनदीति संज्ञां प्राप्य गङ्गया सङ्गता भवन्ति ॥

। ४ । पुनरपि गोस्वामिस्थानशिखरकञ्चनगिरिशिखरयोर्मध्ये सप्तकौशिकाख्या नद्यो वहन्ति तास्त्वेकीभूय कौशीति आख्यां लब्ध्वा गङ्गया सह मिलन्ति । एवमन्येष्वपि तादृशेषु स्थानेषु भवतीति बोध्यम् ॥

। ५ । अथ महापर्वतप्रदेशं त्यक्त्वा ता नद्यो गङ्गासङ्गात् प्राक् कीदृशे प्रदेशे वहन्तीत्याकांक्षायामाह ॥

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एता नद्यो हिमाचलसमान्तरदेशे वर्त्तमानां
सैकतपाषाणपर्वतश्रेणीं भित्त्वा स्वस्वसरणिं
कुर्वन्ति ॥ १३ ॥

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। १ । इयं सैकतपाषाणपर्वतश्रेणी उभयतोऽपि भूपृष्ठात् द्विशतीहस्तप्रभृतिचतुःशतीहस्तपर्यन्तोच्चा भवति । पुनः सूचयति ॥

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सैकतपाषाणपर्वतश्रेण्या उत्तरभागे धूनाख्या प्रदेशा दक्षिणदिशि भावराख्यास्तदधः तराईसंज्ञकश्चेति प्रदेशा भवन्ति ॥ १४ ॥

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। १ । हिमालयविस्तृतिसममितिरेकोनचत्वारिंशत्क्रोशा भवन्ति । तत्र प्रत्येकं त्रयोदशक्रोशपरिमाणास्त्रयो विभागाः स्वदेशविशेषानुसारतः क्रमेणाधरमध्योर्द्ध्वसंज्ञाः स्युः । तत्राधरविभागे तराईसंज्ञको भावरसंज्ञकश्च सैकतपाषाणपर्वतश्रेणीच तत्सम्बन्धिनो धूनाख्यप्रदेशाश्च वर्त्तन्ते । अयं विभागो भूपृष्ठप्रभृतिः समुद्रपृष्ठात् २७०० हस्तोच्छ्रायो यः प्रदेशस्तदवधिर्भवति । ततः समुद्रपृष्ठात् ६७०० हस्तोच्छ्रायो यः प्रदेशस्तदवधिर्मध्यविभागो भवति । ऊर्द्ध्वविभागः शेषः ॥

। २ । अथ पर्वतशिखरप्रदेशाः शीतला भवन्तीति पूर्वं प्रोक्तं । तेन यदि शिखरदेशे हिमं स्यात् तलदेशेचात्युष्णो वायुः स्यात्तर्हि तलाच्छिखरपर्यन्तं प्रदेशे उत्तरोत्तरमवश्यं शीतलो भवेदिति स्पष्टतरं । अथ कतिचन जन्तव उष्णदेशप्रिया अन्येच शीतप्रिया भवन्ति । एवमोषध्यो ऽपि । तथा जन्तव ओषध्यश्च स्वस्वप्रियप्रदेशे पुष्टिमायान्ति । सेयं सर्वस्मिन् जगति वर्तमाना स्थितिरेकस्मिन् हिमालये दृश्यत इति वक्तुमाह ॥

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हिमालये ऽन्येषुचोच्चपर्वतेषु प्रदेशोच्चताविशेषे
ओषधीनां जन्तूनाञ्च विशेषा भवन्ति ॥ १५ ॥

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। १ । तथाहि । ओषध्यः । अधरविभागे सालः शिंशपा

तुन्दः पलाशो वटः पिप्पलश्चेत्यादयो भवन्ति । मध्यविभागेच पूर्वोक्तविलक्षणा इङ्लण्डीयादिदेशेषु प्रसिद्धा वृक्षा भवन्ति येचोष्णदेशे नोत्पद्यन्ते । अथ इङ्लण्डीयादिदेशानामप्युत्तरतो ऽतिशीतदेशेषु प्रसिद्धा ये वृक्षास्तत्सजातीया देवदारुभूर्जादयो वृक्षास्तदूर्ध्वभागे उत्पद्यन्ते ॥

। २ । जन्तवस्तु अधरदेशे उष्णदेशप्रिया वसन्ति किन्तु मध्यदेशे तादृशाः प्राणिनो वर्त्तन्ते ये ऽधरदेशे उष्णताधिक्यात् स्थातुं न शक्नुवन्ति । अथाधरमध्यदेशयोरपि उष्णताबाहुल्यात् स्थातुमसमर्था जन्तव ऊर्ध्वदेशे वसन्ति ॥

। ३ । एवमेव अधरप्रदेशे हस्तिनः खड्गा व्याघ्रा हरिणा-श्चेत्यादयो वसन्ति । मध्यदेशे न हस्तिनो न खड्गा न वा व्या-घ्राः । तत्रच केवलमेका हरिणजातिर्वसति । ऊर्ध्वदेशेतु नैतेषां पूर्वोक्तानां हस्त्यादीनां कश्चन जन्तुरास्ते किन्तु तत्र पर्वतीय-मेषा पर्वतीयाजाश्चेत्यादयस्तिष्ठन्ति । एवमधरप्रदेशजाः काका नोर्ध्वदेशे दृश्यन्ते । तादृशाः कतिपये मध्यदेशे वसन्ति ॥

। ४ । एवं हिमालये तलाच्छिखरपर्यन्तमुत्तरोत्तरं शैत्य-वृद्धेः तादृशा देशविशेषा भवन्ति ये प्रायो भूपृष्ठे सुमहता ऽन्तरेण विना नोपलभ्यन्ते ॥

। ५ । अथ युरोपीयाख्यैः कल्पितानां भूपृष्ठविभागानां वर्णनम् ॥

एशिया आफ्रिका युरोपा अमेरिकाख्याश्चत्वारो भूपृष्ठखण्डा ज्ञेयाः ॥ १६ ॥

भारतवर्षं यत्र वर्त्तते स एव एशियाख्यखण्डः इङ्ग-लण्डसंज्ञदेशो यत्र स एव युरोपाख्योऽपिच ए-शियाख्यखण्डस्य प्रतीच्यां दिशि आफ्रिकायुरोपा-कण्डे वर्त्तेते आफ्रिकाखण्डस्यचोदीच्यां दिशि यु-रोपाखण्डं वर्त्तते भारतवर्षात्कुदलान्तरे अमेरि-काख्यखण्डन्तिष्ठति इदमुत्तरध्रुवसमीपप्रदेशाद्दि दक्षिध्रुवान्तिकप्रदेशपर्यन्तं विस्तृतं भवति ॥ १७ ॥

। १ । अथ कतिचिद्देशा उष्णा भवन्ति कतिचनानुष्णा इ-त्यत्र मुख्यो हेतुरुच्यते ॥

रविकिरणलम्बरूपतिर्यक्पतनानुसारतस्तत्तद्देश-स्योष्णता ॥ १८ ॥

। १ । यो देशो निरक्षासन्नो भवति तत्र रविकिरणा लम्ब-रूपाः पतन्ति अतः स भारतवर्षवदुष्णो देशो भवति । यश्च देशो ध्रुवासन्नो भवति तत्र रविकिरणास्तिर्यक् पतन्तीति स देशः शीतो भवति यथा इङ्गलण्डाख्यः ॥

। २ । पर्वतेभ्यः सरित उत्पद्यन्ते यथा हिमालयाद्गङ्गादय उत्पन्ना इति पूर्वमुक्तं । आफ्रिकादेशेऽल्पाः पर्वता इति तत्र सरितोऽल्पा अतः स देशो निष्फलप्रायः ॥

। ३ । एवं तावत् सङ्क्षेपतो भूर्वर्णिता यस्यां क्वचित् प्रदेशे मनुष्याणां स्थितिर्भवितुमर्हति क्वचिन्न नेति । अथ तेषु प्रदेशेषु मनुष्यवंशानां विस्तृतिर्निवासस्थानविभागश्च यथा जातो यद्वा तैरद्ययावत् कृतं सङ्क्षेपतस्तद् वर्णयितुमितिहासप्रकरणमारभते ॥

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॥ ❋ ॥ इति न्यायकौमुद्यां षष्ठोऽध्यायः ॥ ❋ ॥

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। ४ । अत्र यो लोकवृत्तेतिहासो युरोपीयैः सत्य इत्यभ्युपगम्यते तत्रत्याः स्थूलविषयाः सङ्क्षेपेण प्रदर्श्यन्ते ॥

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सर्वं जगदीश्वरेण सृष्टं तत्राद्यौ दम्पती तदाज्ञोल्लङ्घनात् तदनुग्रहरहितौ बभूवतुरित्येतदेव जगति पापदुःखयोः प्रवेशे मूलमिति ॥ १ ॥

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। १ । आद्यौ दम्पती इति । तौ खलु हिमालयस्योत्तरे

बक्रियानाम्नि देशे न्यूपतुस्तत एव भूमण्डले ऽन्येषु देशेषु मनुष्यजातिः पप्रथ इति ॥

। २ । अथ तयोर्वंशे समुत्पन्नैर्नगरग्रामादिकं निर्मातुमारब्धमित्याशयेनाह ॥

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तत्र प्रथमं निमरोदाख्यो बाबलं नाम नगरं विक्रमादित्यशकारम्भात् पूर्वं वर्षसहस्रद्वयान्तरेण निर्ममे । समनन्तरमेव च ततो नातिदूरे नीनवीनामकं पुरमाराख्यः तद्वंशहूचाशहूरीयराज्ये राजधानीभूतमभूदिति ॥ २ ॥

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। १ । अथ मिश्राख्यदेशे राज्योत्पत्तिरुच्यते ॥

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आफ्रिकेशियाख्यभूखण्डद्वयसन्धानभूतो नीलनदीप्रवाहेण नदीमातृक उपत्यकाप्रदेशो ऽतिचिरातीतकालाद् राज्यस्थानं बभूवेति ॥ ३ ॥

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। १ । यतस्तस्मिन् देशे नीलनदी प्रवहति यया प्रतिहायनमतिशयेन वर्द्धमानया प्लाविता तत्रत्या भूमिर्वृष्टिं विनाप्युर्वरैवेति । तद्धेतोस्तत्र राज्यस्थापनमिति ॥

। २ । अथेब्राहीमाख्यस्य वृत्तान्तमाह ॥

पुरा कदाचिद् बबलदेशवासिनं धनिकं धार्मिक-
मिब्राहीमनामानं कंचन जनं बीचिच्चालितमिस्र-
देशोत्तरभागस्य भूमध्यसमुद्रस्य पूर्वतटवर्तिनि क-
नाननाम्नि देशे गन्तुमीश्वर आदिदेशेति ॥ ४ ॥

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। १ । गन्तुमिति । तत्र गतस्येब्राहीमस्य वंशे उत्पत्स्य-
मानेन पुरुषविशेषेण सकलजगदुद्धारो भविष्यतीति तस्मिन्नेव
काल ईश्वरः प्रतिजज्ञे इति ॥

। २ । अथेब्राहीमवंशवृत्तान्तं सङ्क्षेपात् सूत्रद्वयेनाह ॥

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एवमीश्वराज्ञया कनानदेशं गतादिब्राहीमनाम-
कादिजहाकनामक उत्पन्नस्तस्माद् याकूबनामक-
स्तस्माद् द्वादश पुत्रा जज्ञिरे येभ्यो यहूदीयनाम्ना
सुप्रसिद्धानि द्वादश महाकुलान्युदभूवन् । एकदा
तु याकूबो दुर्भिक्षभयेन सहतनयैर्मिस्रदेशमभि-
श्रियत् ॥ ५ ॥

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मिस्रदेशीया यहूदीयानां सन्ततेर्वृद्धिमालोच्य भी-
तास्तदीयसकलस्त्र्यपत्यघातनेन तत्प्रतिबन्धाया-
यतन्त । यहूदीयास्तु मूसानामकेन नेत्रा ऽधिष्ठि-

ताः सन्तस्तमनातिथेयं देशं विहाय विक्रमादित्या-
त्पूर्वं १४५० तमे वर्षे स्वपूर्वजायेब्राहीमायेश्वरेण
दत्तं कनानदेशं जेतुं प्रतस्थिरे ॥ ६ ॥

। १ । अथ यवनदेशीयं वृत्तं सूत्रत्रयेणाह ॥

भूमध्यस्थसमुद्रस्योत्तरे तीरे मिश्रदेशसमरेखायां यवनाख्यो देशो विद्यते पञ्चनददेशाद् दैर्घ्यविस्तारयोरनधिके ऽपि तस्मिन्ननेकानि राज्यान्यभूवन् ॥ ७ ॥

पुरा यहूदीया आशुरीयैः शूरैर्बलाद् दासीकृत्य स्वदेशे नीतास्त आशुरीयराज्यान्तकेन पारसदेशीयेन कूरशाभिधानेन केनापि विक्रमशकारम्भात् पूर्वं पञ्चशतसंवत्सरान्तरे पूर्विकां वसतिं प्रत्यनीयन्त । तत उत्तरं पञ्चाशद्वर्षाणामपगमे दारानाम पारसदेशाधिपतिर्यवनदेशमाचक्राम । मारथनच्चेत्रे च पराभवमवाप । ततस्तत्पुत्रेनाधिष्ठितैः पारसीकैर्यवनदेशाक्रमणे निष्फलं यतितम् ॥ ८ ॥

अथ जयिनो यवनदेशीयाः पारसदेशस्याक्रमणवै-
रनिर्यातने परिकरं बबन्धः । यच्चेस्कन्दराधिष्ठि-
तैरेतैः पारसदेशाक्रमणमकारि तद् विक्रमादि-
त्यशकारम्भात् पूर्वं वर्षशतत्रयान्तरे वृत्तम् । स-
चेस्कन्दरः पारसीकराज्यमुन्मूल्य भारतवर्षं जेतु-
मविरतं यात्रामकरोत् ॥ ९ ॥

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। १ । जेतुमिति । स हि भारतवर्षमागत्य पञ्चनददेशाधिपतिं पुरुं नाम पराजित्य पूर्वां दिशं प्रति गच्छन् सैनिकान् नानुजिगमिषतो विलोक्य यथागतमार्गेण न्यवर्तत ॥

। २ । एवं किलेस्कन्दरेतिवृत्तविद आहुर्यद् भारतभूमेः परावर्तमानमेस्कन्दरं कलानशर्मा कोऽपि ब्राह्मणोऽनुजगाम स च दुःखातिरेकजननीं जरामापतन्तीमनुसंधाय सहसैव चितामारचय्य तद्दहनज्वालासु निजं देहं प्रक्षिपन् यवनदेशीयान् विस्मापयामासेति ॥

। ३ । तत्र कलान इति नाम भारतवर्षीयनामकरणरीत्यनुरूपं न भाति किन्तु स द्विजो यवनसेनास्थानगमनोत्तरं प्रणमतस्तत्रत्यान् जनान् प्रति कल्याणमस्त्वित्याशीर्वचनमसकृत् प्रयुञ्जानस्तद्भाषानभिज्ञैर्यवनदेशीयैः प्राप्तव्यमर्थादिवत् यदृच्छासङ्केतात्मकेन कलानशब्देन व्यवजह्र इति मन्यामहे ॥

। ४ । अथ रौम्यदेशवृत्तं सूत्रत्रयेणाह ॥

यवनदेशस्य पश्चिमे भूमध्यसमुद्रान्तर्वर्ती मनुष्य-चरणसदृशाकार इतालयनामको भूभागो वर्तते तत्र रोमापुरी नाम राजधानी विक्रमादित्यशकारम्भात् पूर्वं सप्तशतवर्षान्तरे निर्मिता ॥ १० ॥

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विक्रमादित्यशकारम्भकाले च रौम्यैः प्रायेण सर्वे युरोपखण्डान्तर्गता देशा आक्रान्ता अभूवन् । तदा तेषां महासेनापतिः कैसरो नाम बभूव । स चेतालय-देशात् पश्चिमोत्तरे दिग्भागे वर्तमानं फ्रान्सशब्देनाधुना प्रसिद्धं देशं वशीकृत्य तत्र उत्तरस्यां दिशि विप्रकृष्टं ब्रिटान्याभिधं द्वीपं प्राप । तच्चाक्रम्य तस्येङ्ग्लखण्डाभिधं दक्षिणं भागमध्यतिष्ठत् ॥ ११ ॥

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। १ । तच्चाक्रम्येति । तस्मिन् हि देशे या काचन विद्या तदानीमासीत् सा जन्मान्तराभ्युपगन्तृणां नरबलिदानशीलानां च द्रुविदाख्यपुरोहितानां कुले निरुद्धैवास । तस्मिन् देशे खृष्टमतप्रचारस्तु षट्शतसंवत्सरेभ्यो ऽधिके विक्रमशककाले व्यतीते बभूव ॥

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अथ पञ्चशतसंवत्सरमिते विक्रमशककाले ऽतीते महतो रौम्यराज्यस्योत्तरयुरोपीयजनोपद्रवेण ब-

ह्व: खण्डा: सञ्जातास्त एवाधुना पृथक् पृथक् राज्यरूपा युरोपदेशे वर्तन्ते ॥ १२ ॥

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। १ । अथ रौम्यराज्यखण्डान्तर्गतेस्पान्यादेशवृत्तमाह ॥

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तेष्वेकमिस्पान्यानामकं स्थलं फ्रान्सदेशाद् दक्षिणस्यां दिशि वर्तते तच्चाशीत्युत्तरसप्तशतिमिते विक्रमशकस्याब्दगणे ऽतीते महम्मदानुयायिभिर्मुसलमानैराक्रान्तम् ॥ १३ ॥

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। १ । अथेस्पान्यावृत्तमध्ये प्रसङ्गान्मुहम्मदवृत्तमाह सूत्रेण ॥

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मुहम्मद: खल्वशीत्युत्तरषट्शतमिते विक्रमशकाब्दगणे ऽतीते ऽर्वदेशे ऽभिनवं धर्मं प्रचारयामास ॥ १४ ॥

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। १ । प्रचारयामसेति । तेन हि निस्त्रिंशलताबलात् स्वमतप्रचारणाय प्रोत्साहितास्तदनुयायिनो भूमध्यसमुद्रतीरवर्तिष्वाफ्रिकाखण्डमर्यादादेशेषु जयं विस्तारयामासु: ॥

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सप्तशतसंवत्सरमिते ऽपि विक्रमशककाले ऽतीते

इस्पान्यादेशान्मुसलमानानां समूलनिष्काशनं म
हत्तं फ्रान्सदेशस्याक्रमनं कृत्वा तथा तेषां पराभ-
वो बभूव यथैतैः पुनः कदाचिदपि फ्रानसदेशाक्र-
मणे यत्नो न कृतः ॥ १५ ॥

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। १ । अथामेरिकाख्यभूखण्डहत्तं सूत्राभ्यामाह तत्र प्रथ-मसूत्रेण तद्देशोपज्ञाहत्तमाह ॥

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इस्पान्यादेशान्मुसलमानानामपवाहनोत्तरमिता-
ल्यानामकदेशवासी कुलम्बो नाम कश्चिद् बहुभ्यो
राजभ्यो युरोपपश्चिमसमुद्रस्य पारे स्थलस्योपल-
ब्धिप्रकारं न्यवेदयत ॥ १६ ॥

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। १ । न्यवेदयदिति । सह्यतर्कयत् न तावद् भूगोलस्य युरोपैशियासंवलितादर्धादपरस्मिन्नर्धे स्थलं नास्त्येव किन्तु केवलं जलं वर्तत इति सम्भवति । सोऽयं तर्कः प्रथमं बहुजनोपहासास्पदं बभूव । तथाहि केचिदूचिरे भूगोलस्यापरस्मिन् पार्श्वे जनानां स्थितिर्नैव सम्भवति तत्र गतानां तेषां भुवो बहिः पतनप्रसङ्गादिति । अन्ये चैनमुपजहसुः कथमहो भुवोऽधस्तनपार्श्वे त्वया नीताः समूद्रिका नावः पुनरुपरितनपार्श्वे प्रतियास्यन्तीति । ता एताः क्षुद्रशङ्काः कुलम्ब भास्कराचार्योक्तयु-

क्तिसंवादिनीभिर्युक्तिभिर्दूरीचकार । अन्तेचेशबलानाम इस्पान्यादेशमहाराज्ञी तस्य मतमनुमन्यमाना तस्मै नवीनदेशोपलब्ध्यनुकूलजलयात्रासिद्ध्यर्थं समुचितान्युपकरणानि ददौ सचामेरिकाख्यं महान्तं देशमुपलेभे ॥

। २ । अथामेरिकाखण्डसम्बन्धि किञ्चिद् वृत्तं सूत्रेणाह ॥

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अथ भूयांस इङ्ग्लण्डदेशवासिनो जना अमेरिकां
गत्वा तत्र स्ववसतिं स्थिरीचक्रुः ॥ १७ ॥

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। १ । स्थिरीचक्रुरिति । अथ ते स्वीयसङ्घोत्कर्षं विलोक्य वयं मूलदेशीयसाहाय्यं विना ऽप्यात्मनो रक्षणे कुशलाः समर्थाश्च स्म इति निश्चित्येङ्ग्लण्डदेशाधिपाय करदानं प्रत्याचचक्षिरे । तेनावमानेन कुपितैरिङ्ग्लण्डदेशीयैः सह तेषां घोरः सङ्ग्रामः प्रवृत्ते । यदा त्विङ्ग्लण्डदेशाधिपस्तेषां यथेच्छाचारमनुमेने तदा प्रशशाम । ते चेदानीं सम्यगात्मानं पालयन्तः समृद्धसन्ततयो धनिनश्च सञ्जाताः तेषां च नियामको न कश्चित् स्वतन्त्रः सार्वकालिकः किन्तु प्रतिवर्षचतुष्टयं यः कोऽपि पौरजानपदैर्निर्धार्यते स एवेति ॥

। २ । अथेङ्ग्लण्डभारतवर्षयोः सम्बन्धानन्तरं जातानां वृत्तानामारम्भकालं प्रदर्शयितुं सूत्रयति ॥

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पञ्चाशदुत्तरषोडशशतमिते विक्रमशकस्याब्दगणे व्यतीते इङ्ग्लण्डीयैर्जनैर्भारतवर्षेण सम्बन्धः कर्तुमारब्धो येन वर्तमानकालिकी भारतस्य व्यवस्था समजनि ॥ १८ ॥

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। १ । अथ फ्रान्सदेशवृत्तं सूत्रेणाह ॥

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पञ्चाशदुत्तराष्टादशशतमिते विक्रमशकाब्दगणे ऽतीते फ्रान्सदेशीयैरात्मनो राजनियम्यत्वमनिच्छद्भीराजानं व्यापाद्य राष्ट्रव्यवस्थायाः सर्वपौरजनाधीनत्वमापादयितुं बहवो यत्नाः कृताः परन्तु नपोलियन्बोनापार्टनामकस्य सेनधिपस्य हस्ते राज्यं पतितं स पुनरात्मानं राजानं विधाये ग्लण्डदेशविनाशाय परमं यत्नं कुर्वन्नपि तद्देशविनाशं कर्तुं न शशाक प्रत्युतेग्लण्डीयानां कारागारे रुद्ध एव ममार ॥ १९ ॥

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। १ । अचिरादेव रूसदेशीयानां तुरुष्कदेशाक्रमणान्निवारणे फ्रान्सदेशीयावामिग्लण्डीयानां च सख्यं जातं । रूसदेशीया हि वन्यप्राया राजानो बलवन्तः पाटच्चरा इव प्रतिवेशराजभ्यो यदपहर्तुं शक्यते तस्यापहरणं न्याय्यं मन्यन्ते । अथे-

ग्लण्डीयाः फ्रान्सदेशीयाश्चैवंविधचौर्यनीतिदूषणा एकमता भूत्वा तुरुष्कदेशीयराज्यरक्षणे ऽन्योन्यं संहृत्य सवास्तपुलनामकं रूसदेशीयानां महद्दुर्गं विनाशयामासुः । अतः किञ्चित्कालं तुरुष्कदेशाक्रमणोद्योगपरित्यागः सन्धिसंविदङ्गीकारश्चेत्येतदुभयं रूसदेशाधिपतेरापतितं । अथेङ्ग्लण्डीयानां फ्रान्सदेशीयानांच सभ्यतातिशयनिदर्शनत्वात् रूसदेशीयानां च परद्रव्यापहरणोद्योगस्याधिकसाफल्योपायेषु विद्याभ्यासं विनियुंजतां लौकिकप्रजाहितसुखसभ्यतयोः प्रतिपक्षभूताया वन्यताया निदर्शनत्वात् फ्रान्सेङ्ग्लण्डदेशाधिपतीनामन्योन्यसख्यमत्यन्तमिष्टं । परन्तु तत्तत्पुरुषाणामिव तत्तद्देशानामप्यन्योन्यसख्यस्यातिक्षुद्रेणापि कारणेन भङ्गसम्भवादुक्तदेशद्वयसख्यस्य सततानुवृत्तेरिच्छामात्रं वर्त्तते नत्वाशा ॥

। २ । अथैवं प्रदर्शिते लोकवृत्तेतिहासे केनचिद् कर्मणा कस्यचिद् देशस्य धनित्वं केनचित् तु कस्यचिद् दारिद्र्यं जातमिति दृष्टमतो जिज्ञासितं धनवृद्धिह्रासकारणं निरूपयितुं प्रकरणान्तरमारभमाणो धनपदार्थं प्रथमं निरूपयति ॥

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यद् दत्तं सदिष्टफललाभहेतुस्तद् धनं ॥ २० ॥

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। १ । दत्तमिति । स्वेष्टफलस्वामिने समर्पितमित्यर्थः । अतेष्टफललाभहेतूनामपि परस्मै समर्पयितुमशक्यानां प्राण-

वायुसूर्यालोकप्रभृतीनां धनत्वं मा भूदित्येवमर्थं दत्तं सदिति विशेषणम् । इन्धनाच्छादनलवणधान्यादयस्तु दत्ताः सन्तोऽस्मदर्थेऽभीष्टं पदार्थान्तरं संपादयितुं शक्नुवन्तीति तेषु लक्षणसमन्वयः ॥

। २ । सर्यालोकस्य न धनत्वे वस्त्रादेश्च तथात्वमित्यत्र हेतुमाह ॥

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यानि वस्तून्यभीष्टान्यप्यनायासलभ्यानि भवन्ति न तानि धनानि ॥ २१ ॥

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। १ । एवंच स्वाभाविक उपयोगो लाभक्लेशश्च प्रदानविषयेऽर्घमहत्त्वे कारणं तथाहि श्वासवायुस्तावज्जीवनार्थमभीष्टो भवति किन्त्वनायासप्राप्तत्वात् तस्य नार्घमहत्त्वं । एवं तुङ्गाद् हिमालयशृङ्गान्महताऽपि कष्टेनानीतस्याल्पस्य हिमखण्डस्य नार्घमहत्त्वं स्वाभाविकोपयोगाभावात् । धान्यस्य त्वर्घमहत्त्वं भवति स्वभावत उपयोगात् स्वप्राप्तौ कृषिकपरिश्रमादिरूपायासापेक्षितत्वाच्च ॥

। २ । नच हीरकमौक्तिकादीनां स्वाभाविकोपयोगरहितानामपि लाभक्लेशमात्रेणार्घमहत्त्वं विद्यत इति वाच्यम् । तथा सति हिमालयशृङ्गान्महता क्लेशेनानीतस्य स्वल्पहिमखण्डस्यतावन्मात्रेणार्घमहत्त्वप्रसङ्गात् । हीरकमुक्तादीनां स्वाभा-

विकोपयोगराहित्योक्तिस्तु मूर्खप्रलापमात्रम् । स्वाभाविकोपयोगपदस्येच्छापूरणशक्तिपरत्वात् । सा च शक्तिर्हीरकमुक्तादिषु वर्तते तेषामुत्कर्षेण भूषणोपयोगित्वात् । न हि मौक्तिकानां प्राप्तये लोकानां समुद्रमज्जनमापततीत्येतन्मात्रेण तासामर्घमल्पमपितु राजादिजनप्रार्थितत्वात् तासां प्राप्तये सामुद्रिकाः समुद्रे निमज्जन्ति कष्टेन च ता लभ्यन्त इति तासामर्घातिशय इति ॥

। ३ । एवं गण्डूषमात्रं जलमपि यत्रोस्वरभूम्यादौ दुर्लभं तत्र तन्महर्घम् । तथा कारागारनिरुद्धः कश्चिद् वन्दी लोकव्यवहारतोऽर्घरहिते ऽपि स्वच्छे बाह्यवायौ विहर्तुं रक्षिणामनुमत्यर्थं तेभ्यो धनं दातुमुद्यतो भवति ॥

। ४ । अतश्चेष्टवस्तूनामर्घस्य वृद्धिह्रासौ तेषां लाभक्लेशानुसारिणौ । धान्यं हि समृद्धिदशायामल्पार्घं अल्पावशेषतादशायां तु महर्घमिति ॥

। ५ । अथ परिश्रमाणां भिन्नविषयत्वं विना विनिमयः क्रयविक्रयौ वा न भवितुमर्हतो ऽतः परिश्रमाणां विषयभेदं देशधनवर्द्धकत्वेन वर्णयति ॥

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परिश्रमाणां विषयभेदो ऽतिशयेन देशस्य धनं वर्धयति ॥ २२ ॥

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। १ । तथाहि यदि कश्चिन्नागरिको ऽर्थवयात्रां कुर्वन भग्न-

ग्नो भूत्वा दैवाद्अुताद्दृष्टचरे निर्जने कस्मिंश्चिद् द्वीपे तीर-लग्नो भवेत् तर्हि तस्य तत्र स्थितिसिद्धये विविधानामतिसुलभानां जीवनोपकरणानां प्राप्तये निर्माणायच तस्मिन् कालस्य शरीरसामर्थ्यस्य च व्यय आपतेत् । तानि चेमानि शीतवातातपवर्षर्तभ्य आत्मरक्षायै गृहनिर्माणं वन्यान् पशून् हत्वा तन्मांसपचनं विविधवृक्षबीजारोपणं स्वार्थवस्त्रव्यूतिरन्यानि चात्यावश्यकानि । इदं तु स्पष्टं यदेतेन प्रकारेण श्रमदुःखानुगतजीवनधारणमात्रं फलं सिध्येत् किन्तु यावता कालेन मनोयोगेन च तत्कर्मणि कौशलं प्राप्यते तावन्तं कालं मनोयोगं च तत्तत्कर्मणि सफलीकर्तुं स पुमान् न शक्नुयात् । अवर्जनीयकार्यकरणेन प्रतिबन्धात् । परन्तु यदि तत्रैव तत उत्तरमन्यः पुमान् दैवेनानीयेत तर्हि द्वयोरपि चिन्तापरिश्रमौ कश्चिल्लघूकृतौ भवेतां अविभक्तोपकरणसम्पादनानुकूलपरिश्रमस्य ताभ्यां द्वेधा विभज्य स्वीकृतत्वात् । यथा । यद्येकतरौ मृगयादौ बाह्यकृत्ये व्यापृतस्तदाऽन्यतर उभयसुखानुकूलेषु गृहकृत्येषु व्यापृतो भवितुमर्हति । एवंरीत्या तयोः कालो निरर्थकतारहितः स्यात् । मृगयागतो यथा स्वार्थं खाद्यं सम्पादयितुं शक्नोति तथा परार्थमपि एवमेकेन पाकाय प्रज्वालिते वह्निर्द्वयोरप्युपयोगं करिष्यति । एवमेव यावता कालेन तयोरन्यतरः प्रत्येकं स्वस्वोपकरणं साधयेत् ततः किञ्चिदधिकेन कालेन द्वयोरविभक्तोपकरणसिद्धिः स्यात् ॥

।२। यथा वा। कश्चित् पान्थसमूहः शून्यारण्यप्राये देशे ऽन्योन्यरक्षणसिद्धये सार्थवाह इव सम्भूय यात्रां कुर्वन् यदा रात्रौ विश्रामोचितं स्थानं प्राप्नोति तदा सहसैवानुपदिष्टा अपि तत्र केचिद् भारवाहपशुभ्यो भारमवतारयन्ति तृणानि च तेभ्यो ददति। केचित् सन्निहिताद् वनादिन्धनान्याहरन्ति। केचिज्ज-लप्रस्रवणाज्जलमानयन्ति। केचिद् वस्त्रगृहनिवेशने लताभि-श्छायानिर्माणे वा व्याप्रियन्ते। केचित् सर्वेषां कृतेऽन्नं पचन्ति। केचित् पुनः सन्नद्धाः शस्त्रपाणयो भूत्वा स्तेनगणोपद्रवनिरसनाय दत्तावधानाः सन्तो रक्षिण इव समुचितेषु स्थलेषु तिष्ठन्ति। इदं तु तेषां प्रत्येकं स्पष्टमेव विदितं स्याद् यदुक्तविधव्यव-स्थाया अभावे प्रतिपुरुषं जलानयनाय जलप्रस्रवणं प्रति ग-मनमिन्धनानयनाय वनं प्रति गमनं सङ्घान्नपाकानुकूलपरि-श्रमादीषदेवाल्पेन श्रमेण स्वान्नपचनं शत्रुकृतोपद्रवनिवा-रणावधानशस्त्रभारोद्वहन् पुरस्सरं सर्वकार्यानुष्ठानं च प्रस-ज्येत्। किञ्चास्मिन् सङ्घे यदि कश्चिदेकः स्वभावतो ऽभ्यासव-लाद् वा कर्मविशेषे विशेषेण निपुणः स्यादन्यश्चान्यस्मिंस्तथा स्यात् तर्हि तत्तदेव कर्म तस्मै दीयते। परन्तु यत्र सङ्घे प्रद-र्शितं पुरुषवैषम्यं न स्यात् तत्रा ऽपि परिश्रमाणां विषयविभा-गस्य मुख्यं फलमनुभूयेत ॥

।३। अचिरस्थायिन्यामप्यस्यां मण्डल्यां चिरकालस्था-यिन्या राज्यव्यवस्थायाः किञ्चित्सदृशी व्यवस्था दृश्यते तथाहि

राज्यव्यवस्थायां सैनिकगणरूप एकदेशोऽन्येषां रक्षणे व्याप्रियते। वणिग्गणरूप एकदेशोऽन्नसाधनाय सर्वेषां कृते व्याप्रियते। शिल्पिजनरूप एकदेशस्तु वसतिस्थानादिनिर्माणे व्याप्रियते। एवमन्यदपि ज्ञेयम्॥

।४। अथ यो यः परिश्रमं कुरुते स सर्वोऽपि वस्तूनामुत्पादने प्रसक्तो भवत्यतः प्रसङ्गप्राप्तमुत्पादनस्य स्वरूपं वर्णयति॥

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उत्पादनं नाम कस्मिंश्चित् पदार्थे लोकेच्छापूरणानुकूलशक्तिविशेषस्य प्रादुर्भावकरणम्॥ २३॥

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।१। तथाच यस्य पदार्थस्योक्तशक्तिसिद्ध्याऽर्घविशेषः सङ्केतितः स पदार्थः कर्मफलमित्युच्यते॥

।२। अथ कारुणा तत्तत्कर्मफलसिद्धिपर्यन्तं किमुपजीव्य स्थेयमित्याशङ्कायां स्वीयमन्यदीयं वा मूलधनमुपजीव्य स्थेयमित्युत्तरमभिसन्धाय मूलधनं लक्षयति॥

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कर्मफलस्योपादानकारणं निमित्तकारणानि कर्मफलसिद्धिपर्यन्तकारुजीवनसाधनं चेत्येतत् त्रयं मूलधनमुच्यते॥ २४॥

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। १ । अथ परकीयमूलधनोपजीवनपक्षे कर्मफले सर्वात्मना कस्य स्वत्वमित्याकाङ्क्षायामाह ॥

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कर्मफलनिष्क्रयद्रव्यं भृतिर्लाभः कर इति वण्टितं भवति ॥ २५ ॥

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। १ । भृतिर्नाम परिश्रमस्य वेतनम् । लाभो नाम मूलधनस्य मूल्यं । मूलधनस्वामिगामी कर्मफलनिष्क्रयद्रव्यांश इत्यर्थः । करो नाम यस्यामनुपस्कृतं कर्मफलोपादानमुत्पद्यते खनिजलाशयादिसहिततद्भूमिस्वामिगामी कर्मफलनिष्क्रयांशः । अस्य विषयस्योदाहरणादिप्रदर्शनेन सुबहु वर्णनं विस्तरभयान्न क्रियते ॥

। २ । अथ सम्पन्ने कर्मफले तस्य क उपयोग इत्याकाङ्क्षां वारयन्नाह ॥

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कर्मफलान्युपभुज्यन्ते ऽथवा ऽधिकार्घवस्त्वन्तरोत्पत्तौ विनियुज्यन्ते यद्वा वस्त्वन्तरलाभार्थं परस्मै प्रदीयन्ते ॥ २६ ॥

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। १ । तथाच यत्र कुलालः परिधानोपयोगि वस्त्रखण्डमिच्छंस्तन्तुवायाय मृद्भाण्डं समर्प्य तस्मात् पटं गृह्णाति स व्यवहारः परीवर्त इत्युच्यते ॥

। २ । परन्तु कदाचित् कुलाल इष्टवस्त्वन्तरप्राप्तये मृद्भाण्डानि दित्सन्नपि तानि दत्त्वा पटखण्डं ग्रहीतुं नेच्छति तदा तस्मान्मृद्भाण्डानीच्छता तन्तुवायेन तस्मै किमपि तादृशमर्पणीयं यत् तावत् कुलालस्य स्वं भवितुमर्हति यावत् तस्य ग्रहीता फलान्तरदाता च पुरुषो न मिलति। एवञ्च यत् किमप्येवं दीयते यस्य च गृहीतस्य न भोगेन क्षयः किन्तु प्रत्यर्पणमिष्यते तद् व्यवहारे दीनार इत्युच्यते । तच्च केषुचिद् देशेषु नियतपरिमाणकवस्त्रखण्डरूपं प्रसिद्धमन्येषु लवणप्रस्थरूपमितरेषु च वराटकारूपमित्यादि । अथ व्यवहारे केषां वस्तूनां दीनारत्वेन ग्रहणं सुबहूपयोगमित्याकाङ्क्षायामाह ॥

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महर्घधातूनां दीनारत्वेन ग्रहणे क्रयविक्रयव्यवहारो ऽतिसुकरो भवति ॥ २७ ॥

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। १ । अन्यथा तु व्यवहाराणां ह्रासो भवतीत्यर्थः । तथाहि लुकौर्गो नाम स्पार्तीयजनपालः स्वदेशसमृद्ध्युपायविषये विपर्यस्तमतिः सन् महर्घधातूनां दीनारत्वेन व्यवहारे ग्रहणं प्रत्यषेधत् । लोहातिरिक्तधातूनां मुद्राकरणं च नानुमेने । अथ लोहस्य गौरवाधिक्यादल्पार्घत्वाच्च क्रयविक्रयव्यवहारे तत् सर्वथाऽनुपयोगि बभूव तेन क्रयविक्रयव्यवहारो ह्रासं प्राप तेन च प्रजा निर्धना पशुप्राया चाभूत् । अन्यैरपि मौर्ख्यमूलकैर्धनविषयक-

राजशासनैर्देशानां धनं च्चयं नीतं तथाहि हिस्पान्यदेशेतिहासे श्रूयते कदाचित् किन्तु हिस्पान्यदेशीयैः पस्त्नामकदेशविजये तत्रानेके स्वर्णराशयो दृष्टाः । तेन च त आत्मानमक्षय्यधनाध्यक्षं मेनिरे । अथ तैर्धनस्य वास्तवं फलं क्रयविक्रयव्यवहारोत्तेजकत्वमात्रेण सुवर्णस्य महर्घत्वं चापश्यद्भिः स्वर्णस्य देशान्तरगमनप्रतिषेधकं राजशासनं निष्पादितम् । ततश्च येनैव प्रकारेण स्वर्णस्य व्यवहारे कश्चिल्लाभः सम्भाव्यते तेन प्रकारेण तस्य व्यवहारो निषिद्ध इति फलितम् । अथ येषामव्यवहारिपुरुषाणां गृहेषु बहवः स्वर्णराशयः सङ्गृहीता आसंस्तेऽपि तत् सकलं राष्ट्रं चापि जीवनायावश्यकानामत्यन्तसुलभानामपि वस्तूनां प्राप्त्यभावेन दुःखितं बभूव । अत्र स्थाने हिस्पान्यदेशीया राज्यनीतिस्तेन कर्मणा कलङ्किता बभूव यत्करणेनैकाकी पुरुष उन्मत्त इति दूषितो भवेत् । यदि हि स्वर्णमुद्राराशिस्वामी कश्चिदेकः कार्पण्यवशादात्मानं यावज्जीवमन्नाच्छादननिवासादिहीनं कुर्यात् तर्हि निस्सन्देहं चिरस्थायिनोन्मत्ततारोगेणात्मानं हतवानिति लोका वक्ष्यन्ति । एवंविधं च कर्म सुमहता जनसङ्घेन क्रियमाणं तस्य ज्ञानितां न सूचयेदिति ॥

। २ । तदेवं यैः कर्मभिर्देशस्य धनं वर्धते तेषु कानिचित् कर्माणि यथा च स्वभावसिद्धव्यवहारव्यवस्थाया मूर्खकृतो विपर्यासो देशं दरिद्रीकरोति तदपि निरूपितम् । अथ देशधनस्य तन्निवासितत्तत्पुरुषीयधनादभिन्नतया देशानां धनं यया

व्यवस्थया वर्द्धते तथैव व्यवस्थया तत्तत्पुरुषस्यापि धनं हितं न भवेदिति सम्भावनायां नेत्याह ॥

आत्यन्तिकः परिश्रमाणां विषयभेदः परिश्रमकर्तॄणां कल्याणहानिकरो भवति ॥ २८ ॥

। १ । तथाहि आत्यन्तिकेन परिश्रमाणां विषयभेदेन पुरुषो जडेन यन्त्रेण यन्त्रावयवेन वा तुल्यो भवति । तेन च तस्य मनो विस्ताररहितं भवति धीशक्तयश्चांशेनैव प्रादुर्भवन्ति नैव वा प्रादुर्भवन्ति तस्य सूच्यग्रतीक्ष्णीकरणादावत्यल्पायाससाध्य एकस्मिन्नेव कर्मणि सर्वदाऽतिशयेनैकाग्रचित्तत्वादिति ॥

। २ । अथ पुरुषैर्देशधनवृद्धिसम्पादनाय स्वीयं कल्याणं हातुमुचितं न वेत्याशङ्कायामस्य विषयस्य विचारयोग्यत्वेऽपि देशधनवृद्धिह्रासकारणविद्यायामौचित्यस्याप्रकरणत्वात् तन्निरूपणाय प्रकरणान्तरमारभते ॥

। ३ । अथ द्वितीयाध्यायान्त्यसूत्रस्थप्रमेयोद्देशक्रमेण देशधनवृद्धिह्रासकारणानां निरूपणस्यानन्तरं नीतेर्निरूपणं प्राप्तं तस्य प्रस्तावाय प्रसङ्गात् तदनुरूपोऽरिस्तुतिलीयः प्रमेयविभागो विचार्यते । तत्र तावत् प्रमेयाणि न्यायवैशेषिकसांख्यादिशास्त्रेषु स्वस्वमतप्रक्रियामनुसृत्य बहुभिः प्रकारैर्विभक्तानि तान्येवारिस्तुतिलाख्येन जिज्ञासात्रयमनुसृत्य त्रेधा विभक्तानि । तत्र ।

किमस्ति यस्यान्यथाभावकल्पनायां व्याघातो नावश्यमवतरती-
ति प्रथमा जिज्ञासा । किमस्ति यस्यान्यथाभावकल्पनायां व्या-
घातो ऽवश्यमवतरतीति द्वितीया । किं भवितमुचितमिति तृ-
तीया । प्रथमजिज्ञासानिवृत्तये सांसारिकद्रव्यगुणविज्ञाननामकं
शास्त्रं प्रवर्तते । द्वितीयजिज्ञासानिवृत्तये ऽनन्यथाकल्पनीयनि-
यमविज्ञानाख्यं शास्त्रं प्रवर्तते । तृतीयजिज्ञासानिवृत्तये च
नीतिशास्त्रं प्रवर्तते । तद् यथा । पूर्वं मृदुत्वेन प्रतीतः पङ्कः पक्के-
ष्टकारूपेण परिणतः सन् कठिनो भवति सो ऽयं विकारो
विनैव कञ्चन हेतुं जात इति कल्पयितुमशक्यं व्याघातात् ।
तथाच यस्य यस्यारम्भो भवति तस्य कारणमस्तीत्येष नियमः
सिद्धानां जगन्नियमानां मध्ये कस्यापि नियम्यो न भवती-
त्यनन्यथाकल्पनीयनियमविचाराख्यशास्त्रस्य विषयः । अथा-
न्वेषणे कृते स पङ्कस्तदवस्थातः पूर्वमग्निसंयुक्तो बभूवेति ज्ञा-
यते । वह्निः पङ्कस्य काठिन्ये हेतुरित्यस्य त्वन्यथाकल्पने व्याघातो
नावश्यमवतरति । यथा वह्निः सिक्थकस्य मृदुत्वे हेतुस्तथा
पङ्कस्यापि स्यादिति कल्पनसम्भवात् । तदेतद् वह्निना पङ्कस्य
सिक्थकस्य च काठिन्यमार्दवयोर्जननं सांसारिकद्रव्यगुणविज्ञा-
नाख्यशास्त्रस्य विषयः सिद्धजगन्नियमनियम्यत्वात् । अत्र च
वह्निना पङ्कसिक्थकयोः काठिन्यमार्दवजनन औचित्यानौचित्ये
न चिन्त्येते नहि वह्निरेकेन कर्मणा प्रशंस्यते ऽपरेण निन्द्यते वा

परन्तु मनुष्याणां कर्माणि दृष्ट्वा किमुचितं किं चानुचितमिति चिन्ता भवति केषांचित् तत्कर्मणां द्वेषवर्धकत्वात् केषांचिच्च प्रीतिवर्धकत्वात् । तत्र यद् द्वेषं वर्धयति तदनुचितं यच्च प्रीतिं वर्धयति तदुचितमित्युच्यते । अतो ऽनयोः पूर्वकं न कर्तव्यं परं च कर्तव्यमित्यपि व्यवह्रियते । तदेतयोरौचित्यानौचित्ययोरुक्तशास्त्रद्वयविषयत्वाभावात् तद्विषयं शास्त्रान्तरं भवितुमर्हति तच्च नीतिशास्त्राख्यम् ॥

। ४ । अथ वह्न्यादिकर्मणि काठिन्यमार्दवोत्पादनादावौचित्यानौचित्यचिन्ताया अनवतारे ऽपि पुनःकरणप्रवृत्तिनिवृत्तिजनकप्रशंसादण्डयोर्विषयं कर्म कुर्वतां पशूनां कर्मस्वप्यौचित्यानौचित्यचिन्ता कर्तुमुचिता तथाच मनुष्याणां कर्माणि दृष्ट्वा किमुचितं किं चानुचितमिति चिन्ता भवतीति यदुक्तं तन्नोपपद्यते इति चेन्न । पशुमनुष्यस्वभावयोरत्यन्तं वैलक्षण्येन तदुपपत्तेः । तथाहि । प्रतिषेधयोग्यं कर्म कुर्वाणा अपि पशवो वयमनुचितं कर्म कुर्म इति न जानन्ति । न च ते केनापि कदापि कथमप्येनमर्थं ग्राहयितुं शक्यन्ते केवलं त्वमुककर्मणि कृते दण्डो भविष्यतीत्येतावदेव पशवो बोधयितुं शक्यन्ते । मनुष्यः पुनरव्यहितोत्तरागामिप्रशंसादण्डयोरनुसन्धानं विनाप्येतदुचितमेतच्चानुचितमिति ग्राहयितुं शक्य इति सम्यगुक्तं मनुष्याणां कर्माणि दृष्ट्वेत्यादि । तत्रादौ कर्मणां नीतिशास्त्रविषयतायाः स्वरूपमाह सूत्रेण ॥

कर्मणामौचित्यानौचित्यरूपा नीतिशास्त्रविषयता ॥ २९ ॥

। १ । अथौचित्यानौचित्ये केन प्रमाणेन ज्ञातव्ये इत्याकाङ्क्षायामात्मनैव तज्ज्ञानस्य सत्वान्न तत्र प्रमाणजिज्ञासेति तात्पर्येणाह ॥

कस्य कर्मणः कीदृशी नीतिशास्त्रविषयतेत्येतन्निर्णयानुकूल आत्मशक्तिविशेषो मानापमानबुध्द्यनुगतौचित्यानौचित्यकल्पनेत्युच्यते ॥ ३० ॥

। १ । मानापमानेत्यादि । इदं कर्तुमुचितमत एतन्मानयोग्यमिदं च न कर्तुमुचितमत एतदपमानयोग्यमिति कल्पनेत्यर्थः ॥

। २ । नन्वेवंविधकल्पनाविशेषस्यानुसरणं यदस्माभिरवश्यं कर्तव्यं तत् कस्य हेतोरित्याकाङ्क्षायामाह ॥

उक्तस्यात्मशक्तिविशेषस्य प्रभुत्वं तत्स्वरूपपरिज्ञानेनैव स्फुटं भवति ॥ ३१ ॥

। १ । प्रभुत्वं प्रवृत्तिनिवृत्तिकारणत्वयोग्यता । स्फुटं भ-

वतीति । तथाहि उक्त आत्मशक्तिविशेष इच्छाविशेषपूरणसा-मर्थ्यसम्पादनप्रयत्नानामनौचित्यं बोधयितुं शक्नोति । न पुन-स्तथाविधा कापीच्छा वर्तते या प्रयत्नानामुक्तकल्पनापराधीन-त्वस्यानौचित्यं बोधयितुं शक्नुयात् । अत्रेदं बोध्यम् । शक्ति-शक्तिमतोरभेदात् तादृशक्तिविशिष्टो जीवात्मैव तत्तत्कर्मणा-मौचित्यानौचित्यनिर्णये समर्थ इति न तन्निर्णयार्थं प्रमाणा-न्तरापेक्षेति । परन्तु यदा यदा स्वात्मरूपस्यास्योपदेशकस्या-ज्ञां वयमुल्लङ्घयामस्तदा स्वात्मनैव स्वात्मनिन्दामनुभवामः । एतदेवाभिप्रेत्य मनुना ऽपि व्यवहारकाण्डे ऽष्टमे ऽध्याये सा-क्षिणां प्राड्विवाकोपदेशप्रसङ्ग उक्तम् । आत्मैव ह्यात्मनः साक्षी गतिरात्मा तथात्मनः । मावमंस्थाः स्वमात्मानं नृणां साक्षि-णमुत्तममिति ॥

। २ । ननु मार्गप्रदर्शकत्वेनाभिमता पूर्वोक्ता कल्पना कदा-चिद् भ्रमरूपा ऽपि भवति यतो यस्य कर्मण औचित्यमेकेन क-ल्प्यते तस्यैवानौचित्यमन्येन कल्प्यते न च विरुद्धयोर्द्वयोरपि कल्पनयोर्याथार्थ्यं सम्भवति । अतः सा कथं विश्वसनीयेत्याका-ङ्क्षायामाह ॥

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उक्तात्मशक्तेर्बहुष्वल्पेषु वांशेषु प्रकाशनं भवति ॥ ३२ ॥

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। १ । अयं भावः उक्तात्मशक्तेरुचितानुचितभेदज्ञानरूपत्वान्मनुष्यजातीयज्ञानमात्रस्य च सर्वविषयकत्वासम्भवद्भ्रान्तित्वयोरभावादिदं सिध्यति यद् यावतांशेन धर्मविषयकं ज्ञानं भ्रमात्मकं स्यात् तावतैवांशेन तदनुगाया मानापमानबुद्धेर्भ्रमत्वं सम्भवति ॥

। २ । ननु यदि कश्चित् पुरुष उक्तकल्पनारूपात्मशक्तिबलादनुचितमपि कर्मौचितबुध्या करोति तर्हि सो ऽपवादमर्हति नवेति सन्देहे ऽर्हतीति ब्रूमः अवश्यं निराकर्तुमुचितस्याज्ञानस्य कदापि निन्दामुक्तेरभावात् यतो यदा स्वकल्पनापरवशैरस्माभिर्वस्तुतो ऽनुचितमप्युचितबुद्ध्या क्रियते तदा ऽस्माकं दोषो न तादृशकल्पनानुसरणरूपः किन्तु येषां नियमानां ज्ञानं नीतिशास्त्रनियोज्यैरस्माभिरवश्यं सम्पादनीयं तन्नियमाज्ञानरूप इति ॥

। ३ । अथोक्तात्मशक्तेः प्रकाशनकारणमाह ॥

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एषा सप्रयत्नविचारेणागमेन वा स्वस्य प्रकाशनमपेक्षते ॥ ३३ ॥

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। १ । अथ सुफलत्वौचित्ययोः सामानाधिकरण्यविषयको विचार उक्तात्मशक्तिप्रकाशने सहकारीत्यत्र हेतुमाह ॥

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न कस्याप्युचितकर्मणोऽन्त्यफलं दुःखदं न च कस्या-

प्यनुचितकर्मणोऽन्यफलं सुखदमिति ॥ ३४ ॥

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।१। आगमेन तादृशात्मशक्तिप्रकाशनप्रकारस्तु स्फुट एव ॥

।२। ननु कानि तानि कर्माणि यानि प्रकाशितयोक्तात्मशक्त्या विधीयन्ते निषिध्यन्ते वेत्याकांक्षायां तन्निवारणार्थं कर्माणि विभजते ॥

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ईश्वरस्य लोकस्य स्वस्य चोद्देशेन सुकर्माणि
क्रियन्ते ॥ ३५ ॥

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।१। तत्रेश्वरोद्देश्यकं कर्म भीतिः प्रीतिश्चेति द्वयम् । मनुष्येण हीश्वरोपदिष्टकर्मणां सप्रीत्यनुष्ठानं कर्तव्यमतो यदीश्वराद् भयं न स्यात् तर्हि तदाज्ञापालनमेव न भवेत् यदि चेश्वरे प्रीतिर्न स्यात् तर्हि तदाज्ञापालनं प्रीतिपूर्वकं न स्यादिति । लोकप्रीत्युद्देश्यककर्माणि द्वेधा भवन्ति व्यवहारनियमप्राप्तानि तदन्यानि चेति । तत्र प्रथमान्यस्तेयादीनि । पराणि कृपादीनि । अथ स्वोद्देश्यककर्माणि स्वजीवरक्षणमनतिप्रसङ्गो हृदयशुद्धिरिति त्रीणि ॥

।२। अथ लोकोद्देश्यककर्मणां यद् द्वैविध्यमुक्तं व्यवहारनियमप्राप्तानि तदन्यानि चेति तत्र प्रथमस्य प्रकारस्य निरूपणाय व्यवहारनियमप्रकरणमारभते । तत्रादौ बेकनाचार्येण प्रदर्शितं व्यवहारनियमप्रयोजनविभागं दर्शयति ॥

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मरणबलात्कारभयान्मनुजशरीररक्षणं स्थावरा-
स्थावरतदीयधनव्यवस्थापनं जुगुप्सानिन्दाभयात्
तद्यशोरक्षणं चेति त्रीणि प्राधान्येन व्यवहारनि-
यमप्रयोजनानि ॥ ३६ ॥

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।१। अथ ये इष्टव्यवहारनियममूलभूताः सिद्धान्ता इदानीं प्रसिद्धेषु व्यवहारनियमग्रन्थेषु विस्तरेण वर्णिता येषां सम्यग्वि-नियोगेन व्यवहारनियमाः सिद्ध्यन्ति ते कतिपय इह प्रद-र्श्यन्ते ॥

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सामान्यविशेषसुस्थित्योः सामान्यसुस्थितिर्ब-
लीयसी ॥ ३७ ॥

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। १ । तथाहि विपत्काले यदि विशेषसुस्थितिभङ्गादेव सामान्यसुस्थितिः सम्भवति तर्हि सामान्यसुस्थितिरेवादरणीया न तत्तद्विरोधिनी विशेषसुस्थितिः । यथा यद्येकस्य गृहस्य जायमानाद् दाहात् सर्वस्य नगरस्य दाहः प्रसज्यते तर्हि तस्य समूलोच्छेद एव दाहप्रसरनिवृत्त्यर्थं कर्तव्यः ॥

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विप्रतिषेधे पूर्वं व्यवहारनियममुत्तरो बाधते ॥ ३८ ॥

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उत्पन्नो व्यवहारनियमो ऽतीतेषु स्वविषयेषु न प्रवर्तते किन्त्वनागतेष्वेव ॥ ३९ ॥

।१। अतीतेष्विति। अपराधदण्डविषयकस्य व्यवहार-नियमस्यातीतविषयप्रवर्तने न्याय्यत्वाभावः स्फुटः तथाहि कस्यचित् कर्मणः करणोत्तरं नवोत्पन्ननियमबलात् तस्य कर्मणो ऽपराधत्वमुद्भाव्य तत्कर्तुर्दण्डदानमन्याय्यं तत्कर्त्रा करणकाले ऽनपराधत्वेन सिद्धस्य कर्मणो भाविनियमविशेषानुसारेणापराधत्वं भविष्यतीत्येतस्य पूर्वं ज्ञातुमशक्यत्वात् तथाच तादृशस्थले स पुरुषो नापराधी ततश्च तस्मिन् क्रियमाणो दण्डो ऽप्यन्याय्य एव ॥

।२। क्वचित्त्वतीते ऽपि धनादिविषये नवोत्पन्नव्यवहार-नियमस्य प्रवृत्तिरिष्टा अपराधदण्डधनविभागयोर्वैलक्षण्यात् ॥

स्वविवादे स्वस्य न निर्णायकत्वम् ॥ ४० ॥

।१। यत्र प्राड्विवाक एव वादिप्रतिवाद्यन्यतरो भवति तत्र स स्वयं साक्षात् प्रतिनिधिद्वारेण वा स्वविवादपदनिर्णये समर्थो न भवतीत्यर्थः ॥

यो विषयो ऽधिकरणे विवादास्पदं स एव तस्य

विवादस्य प्रतिबन्धको न भवति ॥ ४१ ॥

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।१। यथा जातिभ्रष्टः पुरुषः कस्मिन्नपि व्यवहारे वक्तुं नार्हतीति व्यवस्थासत्त्वेऽपि यदि कश्चिदभिशस्तः पुरुषः स्वस्मिन्नुद्भावितस्य जातिभ्रंशस्यान्याय्यत्वं साधयितुं विवादमिच्छेत् तर्हि वक्तुमर्हति जातिभ्रंशस्य स्वविषयकविवादप्रतिबन्धकत्वाभावात् ॥

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यो यस्मिन् विषये परस्परपराहते वचन उपन्यस्यति स तस्मिन् विषयेऽनधेयवचनः ॥ ४२ ॥

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।१। यथा यदि कश्चन पुरुषः पूर्वं क्लेशभयादस्मिन् विषयेऽहं रक्षणाधिकृतो न भवामीत्युक्त्वा पश्चात् तद्विषयसम्बन्धिदक्षिणालाभकालेऽहं रक्षणाधिकृतो भवामीति ब्रूयात् तर्हि तस्य वचनं न श्रोतव्यम् ॥

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स्वधनमपि तथोपभोक्तव्यं यथा न परबाधा स्यात् ॥ ४३ ॥

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।१। यथा स्वक्षेत्रस्यापि पार्श्वे सत्यामिच्छायां गृहं तथा निर्मातव्यं यथा प्रणालीभिः पतन्त्यो वर्षधाराः परगृहं न बाधेरन् ॥

। २ । तदेवं ते व्यवहारनियमा निरूपिता येषां लौकिकप्राड्विवाकैः प्रणीयमानो दण्डः प्रमाणम् ॥

। ३ । एवं व्यवहारनियमप्राप्तानि लोकोद्देश्यककर्माणि प्रदर्शितानि । अथ येषां प्रयोजको न लौकिको दण्डोऽपितु यद्विषयके प्रवृत्तिनिवृत्ती परमेश्वरस्यालौकिकप्राड्विवाकभूतस्य प्रीत्यप्रीत्योरनुसन्धानेन भाव्ये तानि लोकोद्देश्यककर्माण्याह ॥

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येषामकरणे लौकिकदण्डो न भवति तानीश्वरप्रियाणि लोकोद्देश्यककर्माणि दयाकृतज्ञताप्रभृतीनि ॥ ४४ ॥

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॥ ❋ ॥ समाप्तं नीतिप्रकरणम् ॥ ❋ ॥

। १ । अथ यत् पूर्वप्रकरण ईश्वरं सिद्धवत् स्वीकृत्याभिहितं तत्र सांख्याः प्रत्यवतिष्ठन्ते नास्ति नित्य ईश्वरः प्रमाणाभावादिति तान्निराकर्तुमीश्वरसत्त्वे प्रमाणप्रदर्शनाय जगत ईश्वरजन्यतां प्रमेयोद्देशक्रमप्राप्तां निरूपयितुं प्रकरणान्तरमारभते ॥

। २ । अथ सिद्धान्तमुक्तावल्यां विश्वनाथभट्टाचार्येणेश्वरसाधनार्थमिदमनुमानमुपन्यस्तं । यथा पटादि कार्यं कर्तृजन्यं तथा क्षित्यङ्कुरादिकमपि नच तत्कर्तृत्वमस्मदादीनां सम्भवतीति

तत्कर्तृत्वेनेश्वरसिद्धिरिति । तत्रैवंविधानुमानमूलभूतं सिद्धान्तं दर्शयति ॥

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प्रयोजनानि दृश्यमानानि प्रयोजकं साधयन्ति ॥ ४५ ॥

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। १ । प्रयोजनानि दृश्यमानानीति सिद्धानि कार्याणीत्यर्थः । तथाहि सिद्धतस्तस्य तस्य कार्यस्य दर्शने सतीश्वरवादी नियतमिमां शंकामुपन्यस्यति । यथा । यद्यहमेतत् कार्यं लौकिकैरुपायैर्निष्पादयितुमिच्छामि तत्क्रियानियमनरीतीश्च वेद्मि तर्हि किमत्र दृष्टयैवैतत्कार्यसम्पादनरीत्या रीत्यन्तरेण वा तस्य सम्पादने प्रयतेयेति । यद्यत्रोत्तरं न रीत्यन्तरेणेति तर्हि स्फुटमेतत् सिद्धति यत् कश्चिद् बुद्धिपूर्वकारी पूर्वोक्तलौकिकनियमज्ञानवान् शक्तिमान् कर्ता तत्कार्यसम्पादने दृश्यमानानि साधनानि नियोजयामासेति ॥

। २ । ननु यथा क्षीरं स्वयमेव वत्सार्थं गोरूधसि प्रादुर्भवति तथा जडाऽपि प्रकृतिः स्वयमेव पुरुषार्थं विविधानि कार्याणि करोति । तदुक्तमीश्वरकृष्णाख्येन । वत्सविवृद्धिनिमित्तं क्षीरस्य यथा प्रवृत्तिरज्ञस्य । पुरुषविमोक्षनिमित्तं तथा प्रवृत्तिः प्रधानस्येति । तथाच निष्प्रयोजना चेतनकर्तृकल्पनेति चेन्नेत्याह ॥

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मैवं चीरस्यापि वत्सार्थं स्वयमेव गोरूधसि प्रादु-
र्भावाभावेन दृष्टान्तासिद्धेः ॥ ४६ ॥

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।१। श्रूयतां तावदिदमुपाख्यानं यदस्यैवार्थस्यान्योक्तिविधया द्योतकं। यथा कश्चिद् राजपुत्रः पार्श्ववर्तिभिरुपहृतमन्नं नित्यं क्षुद्बोधसमयेषु स्वगृहद्वार्युपसीदतीति दृष्ट्वा निगमयाञ्चक्रे पक्वमन्नं मदर्थं स्वतएव प्रादुर्भवतीति तथैव च सखायमुवाच स चैनं प्रत्यबोधयत् त्वत्पितुर्नृपतेरिच्छया प्रवर्तिकया जातानां नानाविधानामनुकूलप्रयत्नानां फलमिदं नतु स्वतएव त्वदर्थं प्रादुर्भवतीति ॥

।२। एवमेव प्रकृतिर्नास्मदाद्यर्थं स्वयमेव यतते ऽपितु दिव्यस्य जगज्जनकस्येच्छया प्रवर्तिता सत्येवेति॥

।३। ननु प्रकृत्यधीश्वरस्येच्छाः कथं मनुजेन साक्षात्कर्तव्या इत्याकांक्षायां परमेश्वरेच्छासाक्षात्कारोपायमाह॥

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ईश्वरेच्छाद्योतकत्वेन तत्तत्पुरुषाभिमतानि शा-
स्त्राणि परीक्ष्याणि ॥ ४७ ॥

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।१। ननु तादृशानि शास्त्राणि यदि नाना तर्हि कतमं

श्रमं परीक्ष्यमिति चेदुच्यते । तथाहि जिज्ञासुः प्रथममेतमस्मदीयमुपदेशमाद्रियतां यथा यच्छास्त्रं नानाविधनिर्घृणापापिष्ठक्षुद्रकर्मसहितं शिलापुत्त्राद्यनीश्वरपूजनं विधत्ते तदीश्वरादायातमिति न सम्भवति । तथा यत् शास्त्रं स्वाविश्वासिहन्तॄणां परलोके वैषयिकसुखातिशयबोधनद्वारा लोकान् प्रलोभयति तदपीश्वरादायातमिति न सम्भवति । परन्तु यदि तादृशं किमपि शास्त्रं लभ्यते यत् पुंसो हृदयस्य शुद्धिमीशभक्तिं लोकोपकारप्रवृत्तिं च विदधाति तर्हि तत्रत्यविधीनां साधकानि प्रमाणानि परमपुरुषार्थार्थिभिर्विद्वद्भिरवधानपूर्वकं परीक्षणीयानीत्युचितं भवति । तामेतां जिज्ञासां भगवान् सफलयत्विति शम् ॥

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इति श्रीमज्जेम्स्ब्यालण्टैनविरचितायां न्यायकौमुद्यामितिहासो देशधनवृद्धिह्रासकारणं नीतिर्जगत ईश्वरजन्यता चेत्येतन्निरूपणं नाम सप्तमोऽध्यायः ॥

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॥ ❋ ॥ इति न्यायकौमुदी समाप्ता ॥ ❋ ॥